Madurai Kamaraj University

(University with Potential for Excellence)

Distance Education

M.B.A.

SECOND YEAR

IV Semester

Elective IV - Production

VALUE ENGINEERING & WASTE CONTROL

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SYLLABUS

VALUE ENGINEERING AND WASTE CONTROL

1) Background and significance of value engineering , efforts of changing technological, commercial and governmental factors –VE as a new discipline – general operation and costs – relations of VE to other operations.
2) The principle of value engineering; problem recognition and definition; the role of creativity – the criteria for comparison – the element of choice.
3) The meaning and analysis of function – the general concepts – meaning of use esteem and exchange values – anatomy of functions – basic Vs. secondary Vs. unnecessary functions – using and evaluating functions.
4) The role of management in value engineering an integral part of the VE programme – responsibilities – organization for VE orientation of management – budget auditing merit recognition.
5) Value engineering techniques – selecting product and operations for VE action how to time the VE programme – determining and weighing the function(s) assigning money equivalents developing alternatives in decision making measuring – benefits – reporting results – follow-up.
6) Value and decision – decision process – theory of the decision-matrix (linear programming) - concept of utility make or buy.
7) Scheduling of value engineering activity Manns system Gantt charts – PERT charts and techniques – net work logic critical path method (CPM) use of control charts.
8) Organization and staffing for value engineering; general organisation concept – relation of organization to expected VE actions centralization Vs. decentralisation – level of VE in the organizations – small plant VE activity – size and skills of VE staff.
9) Training for value engineering – objectives – initial programme – management orientation agenda – detail training of value engineers – introduction of peripheral personnel – who should conduct training – programme costs.
10) Value engineering at work – variety reduction – case studies with costs of VE efforts improving function quality performance, reliability and market values, and in decreasing direct and indirect labour costs – material cost – capital cost.

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BACKGROUND AND SIGNIFICANCE OF VALUE ENGINEERING

1.1 INTRODUCTION TO VALUE ENGINEERING

Value Engineering is a management technique that targets the best functional balance between the cost and the performance of a product or project without compromising the reliability of the same. It seeks to promote progressive change by identifying and removing unnecessary cost.

Value Engineering is a multidisciplinary team effort to identify and remove unnecessary costs while maintaining the performance and the reliability at the same time.

Value Engineering deals with creation of values with utmost economy. It is concerned with a detailed dissection of the price of every component of the finished product purchased or manufactured to find out whether the best value for the money spent on, it is obtained.

It is a powerful tool of cost reduction which the present day industrial business has necessarily to exercise in order to be able to survive as a viable enterprise, particularly in view of the oppressive influence of inflation, inadequate competition, increasing price trends, unfavorable balance of trade and restriction on import of raw materials and accessories.

According to Woodward "Value Engineering is a system of techniques of accelerating identification and modification of unnecessary costs in a production or service. Firstly it identifies what the customer needs and what a component must do, then it determines the lowest cost at which these needs can be reliably fulfilled; lastly it motivates the action which must be taken to provide with necessary functions at the lowest total cost".

According to Nary "Value Engineering is an objective appraisal of all elements to design, construction, procurement, installation and maintenance of equipment including the specifications to achieve necessary functions, maintainability and reliability at minimum cost".

Davis describes "Value analysis is an organized and functional approach to the elimination of unnecessary costs by studying relationship between the function and cost, without sacrificing performance, Quality, reliability and maintainability", Tangerma says, "Value Engineering is not just cost reduction, it is an analysis of functioning at the lesser cost."

Essentially Value Engineering is a scientific application of all known techniques of cost reduction for achieving economy with efficiency, without sacrificing the aesthetic value.

It starts with an enquiry into the functional utility of an item and then proceeds to measure its value or intrinsic worth in terms of the functions required to be performed, followed by investigation as to how the value can be improved either by obtaining better performance or by reducing cost or both or by obtaining some additional advantage such as conservation of materials obtainable from indigenous source.

Value Engineering is "an organized creative approach which has as its objective, the efficient identification of unnecessary cost – cost which provides neither quality nor use, nor life, nor appearance nor customer features". Value Engineering focuses engineering, manufacturing and purchasing attention to one objective – equivalent performance at a lower cost i.e. functional performance remains unaffected.

Value Engineering (VE) is the process of determining the value of a product and/or service during various stages of the product life-cycle (PLC). The design stage provides more freedom for Value Engineering to get better results. During the maturity stage in PLC, the focus will be on components. Here the cost reduction is possible through substitution and locating alternate sources of the original components. Just as industrial engineering highlights productivity in industries, value engineering highlights the awareness of determining values to establish the cost of every item or activity of human endeavor.

Value analysis aims at a systematic identification and elimination of unnecessary costs resulting in the increased use of alternatives, less expensive material, cheaper designs, less costly methods of manufacturing etc. to pro-

vide the same performance, quality and efficiency and in a decrease of overall unit costs and consequently greater profits.

Suppose a housewife is shopping for vegetables. There are four varieties of tomatoes to choose from, costing Rs.1.50, Rs.2.00, Rs.3.00 respectively. Which one will she buy? Quality? All are of good "quality." Price? Obviously not, Then the vegetable vendor won't be able to sell the other three qualities.

The answer is simple. She will buy that quality which serves her purpose. For example if her husband's boss is coming for dinner and tomatoes are required for the salad, the Rs.3 variety will be the obvious choice. If she wants to make tomato-rasam, then she will purchase the Rs.1.50 quality. In other words, her choice will depend on the function the tomato is to perform. Each of the four varieties has a value and this value depends on the function it is expected to accomplish. This small example illustrates the approach of Value Analysis.

Value Analysis is, in essence, a study of function. The function of a part, or material, or service is the job it does. Value is the price we pay for a product process, material or service required to perform a specific function is an efficient way. We get the best value when we incur the least cost for an essential function or service with the required quality and reliability. The task of value Analysis is to ensure that all the elements of cost whether for labour, for material, for designing or for services, contributes proportionately to the function.

Value Engineering is an organized creative approach to ensure that the essential functions of a product or process or the services are provided at a minimum overall cost without sacrificing quality or reliability.

The biggest return is usually obtained by achieving better value in design during the initial conceptual and design stages. This is usually to as value engineering.

No one today can deny the need for more cost consciousness in the design, development, production and maintenance in industry as a whole. The need has been recognized for many years. However, the ever increasing pace of technological advances and the increased competition for world markets have focused more direct attention or the problem and value engineering has become a demanding tool.

Value Engineering means the getting together of all the available technical know-how within and without the company and coordinating individual

activities into a value engineering team for the purpose of obtaining the required function at the lowest cost.

Value analysis is a cost reduction technique and perhaps the most potent of all such techniques. Cost reduction is a very dynamic concept unlike, for example, cost control. In cost control we are aiming to keep cost within predetermined standards while in "Cost Reduction" our objective is to attack the costs themselves and eliminate them where possible.

Stated very simple "Value Analysis is an organized procedure for efficient identification of unnecessary cost". Another definition states: "Value Analysis is the study of the relationship of design, function and cost of any product, material or service with the object of reducing its cost through modification of design or material specification manufactured by a more efficient process, change is source of supply (external or internal), or possible elimination or incorporation in a related item".

A more elaborate definition of Value Analysis as given below throws more light on the subject.

"Value Analysis is the organized and systematic study of every element of cost in a part, material or service to make certain it fulfills its function at the lowest possible cost; it employs techniques which identify the functions the user wants from a product or service; it establishes by comparison the appropriate cost for each function; then it causes the required knowledge, creativity and initiative to be used to provide each function for the lowest cost".

L.D. Miles defined VA "as an organised creative approach which has for its purpose the efficient identification of unnecessary cost i.e. cost which provides neither quality, nor use, nor life, nor appearance, nor customer features". VA was traditionally used in the area of hardware projects but is now a days applied in software projects too. In non- traditional areas like customer service plans in banks, slum development, motivational techniques, VA can be of great use.

It is usually difficult to specify value mainly because value changes from person to person. The value of a can of water to a thirsty man varies with the man's distance from the source of supply. The value of ship's compass to its navigator is vastly different from its value to a housewife. The obvious logic of these statements illustrates that value is variable. Value, though a broad term, has been categorized so that it can be defined meaningfully.

Generally speaking, there are seven classes of value economic, moral,

aesthetic, social, political, religious and judicial. Of these, only the economic classification can be considered to be objective. It is the only one which can be measured. The others can be evaluated only subjectively.

Within the class "Economic Value", there are four subdivisions:

Use Value	Properties which accomplish a use, a work or a service.
Esteem Value	Properties which make the ownership of the object very desirable
Cost Value	Properties which are the sum of the labour, materials, overheads and other costs required to produce that object.
Exchange Value	Properties that make the object possible of being trade for other items.

It is apparent that only, "Use Value" is objective.

In almost everything we buy, we relate what we get to what we have paid for in terms of performance, reliability, appearance etc.

If we can collectively term these as "function'. Then we can express value in a mathematical way, i.e.

$$\text{Value} = \frac{\text{Function}}{\text{Cost}}$$

By cost, we mean the total cost (e.g. cost of material, labour, overheads etc.) required to produce the article. If we keep the function constant, we sec that we get greater value when our costs come down.

Value can be increased

(1) When we reduce costs

(2) When we improve function

(3) By (1) and (2) together

(4) When we increase function by a disproportionately low Increase in costs.

Usually most of us lack the ability to measure value. In industry most of us are performance or delivery oriented and we hardly search for or get cost information. Practice of value analysis sharpens this latent ability to determine worth and measure value and more than all to eliminate unnecessary costs.

Use Value

The monetary measure of the properties and functions of an item or

service which contribute to its functional performance. In other words, it refers to the features which make the product functionally component.

Esteem Value

This is the monetary measure of the properties and functions of an item or service which contribute to its esteem demand and saleability. In other words, it refers to the special features which makes one want to possess the item or service.

Cost Value

This is the monetary measure of input efforts such as material, labour, overhead, required to produce an item or service which contribute to its cost and saleability.

Exchange Value

This is the monetary measure of the properties and functions which contribute to its exchange ability for something else. Normally, the sum of use value and esteem value is equal to or greater than the exchange value, viz. Use value + Esteem value ³ Exchange value.

Time Value

It is value determined predominantly by the time of availability of the item or service. Computers are capable of computing fast and hence are capable of giving their services (solutions to problem) without any time delay. This is time value.

Place Value

Value of an item or service depends upon its availability at a place where it is required. Water provided to a traveler in a desert and life-saving medicine made available to a dying patient at the hospital, imported materials made available to a manufacturer at his factory are examples of place value of an item or service. The traveler in a desert is prepared to pay a higher price compared to one in the plains to get a bottle of water because he attaches higher value to satisfy his thirst at the desert.

From the above it is clear that value is not unique. It varies with perception of people who buy the item. Thus value is not intrinsic but extrinsic. Values are created by the society and by the people.

People are again influenced by the value system inherited by them. Value systems of people are conditioned by the history, culture, religion, political system or ideology. Values also vary from place to place and time to time.

This explains the different price one is prepared to pay for a cup of tea in a roadside restaurant and a five star hotel. Persons who are satisfied for a given value of an item or service are prepared to pay the corresponding price to buy the same. This is the cost of possessing the item or getting the service desired. In the case of the industries, customers' needs are fulfilled by the performance of the product. This is the desired customer value. Having incorporated the desired function in the product to satisfy the customer' need, the industry may also add some other features to increase its original value. This is called esteemed value. With this, the product will be more attractive to the customer. This in turn will make the customer to pay more. This added value will fetch better price to the product and profit to industry by successful competition in the market.

Based on these classifications, value may be defined as the minimum money, which has to be expended in purchasing or manufacturing a product to create the appropriate use or esteem factors. However, value is not inherent in a product, it is a relative term and value can change with time and place. It can be measured only by comparison with other products which perform the same function. Value is the relationship between what some one wants and what he is willing to pay for it.

The term "value" is used in many different ways and consequently, has many different meanings. It is frequently confused with the monetary price or cost of an item. Value to the manufacturer or procurement activity has a different meaning than does value to the user. Even the user may have different concepts of value, depending upon the time, place, and the availability of substitute items.

Another, perhaps more meaningful, way to define value is to break it down into the four categories listed below:

1. **Cost Value** - the summation of the labour, material, overhead, and all other elements of cost required to produce an item or provide a service compared to a base. This is almost always expressed in money.
2. **Use Value** - the properties and qualities which accomplish a use, work or service compared to a base- the properties and qualities of a product or material, which accomplish a use, work or service. The use value is equal to the value of the functions performed.
3. **Esteem Value** – the properties, features or attractiveness which create a desire to possess the article and which are not necessarily required so

far as functional performance is concerned. But this contributes to the pride of ownership of the product.

4. **Exchange Value** – the properties or qualities which other people to permit market resale in the future.

The following is a check-list of ten tests for value complied by the purchasing department of General Electric Co., U.S.A. and it is considered most desirable, if not absolutely essential for every material, every part and every operation to satisfy these tests:-

1) Does its use contribute value?
2) Is its cost proportionate to its usefulness?
3) Does it need all of its features?
4) Is there anything better for the intended use?
5) Can a usable part be made by a low-cost method?
6) Can a standard product be found which will be usable?
7) Is it made on proper tooling considering quantities used?
8) Do material, reasonable, labour overhead and profit, total its cost?
9) Will another dependable supplier provide it for less?
10) Is anyone buying it for less'?

Value analysis seeks answers to the following questions which may be asked about a product, a component or process:

(1) What must this item or process do? What is its function? (This can usually be expressed in two words e.g., a bulb "provides light" or a paint "provides protection", or "enhances appearance".

(2) What else does the item do? (If the item performs functions that are not needed, then it may be a symptom worth investigating to find out if there is a waste).

(3) What does it cost?

(4) What else could perform the same function?

(5) What will be a possible substitute's cost?

It is usually said that one of the most important reasons for the success of Japanese business is the word "WHY?". Having a constructive discontent of everything around them, it is said, is a part of the Japanese character. The result is they want change. This is exactly the philosophy of value Analysis. Someone has described this philosophy by the following parody of the famous poem

Ours is not to do or die
Ours is to question WHY.

Add to this, Kipling's famous SIX honest serving men: What, Why, When, How, Where and Who and the profile is complete.

Studies consistently prove that all designs have unnecessary cost regardless of the brilliance of the designers. Even inventions in the field of science have at later stages, been improved either by the inventors themselves or by others. This provides ample scope for the application of Value Engineering/ Analysis techniques.

The basic objectives of value engineering activities are:

- Reduce cost without reducing quality
- Increase value without increasing cost
- Increase value for the given cost

Therefore, the three important factors relevant here are quality, cost, and value. The term value has been defined already. It is a well-Known fact that quality can be bettered by improved design by use of high quality materials and by better workmanship. This costs money. Higher the quality, higher is the cost. However the value of the equipment need not necessarily increase in the same proportion as that of the cost. In the extreme position where quality is so poor it has negative value, meaning that the customers must be paid incentive to buy the item. At higher quality level, the cost goes up at 'increasing rate' whereas the value goes down at 'decreasing rate'. The desirable quality level lies between these two extremities. There is a region of quality level where the value of the product, improves with 'increasing rate' compared to cost which shows 'decreasing rate' of increase. Value engineers operate in this region. Their efforts are to locate "that point of quality level where the value is maximum for a given cost. In other words, the objective function of value engineering is to maximize the incremental ratio M = Value / cost or *(dV/dC)*. In fact this ratio is the measure of value of product for a given quality. When *(dV/dC)* is maximum, it gives optimum value of the product for the given quality. Thus we have:

$$\text{Value} = \frac{\text{Quality}}{\text{cost}}$$

Therefore the value of a product can be increased the quality, and reducing the cost. The measure of success of value engineering depends on the value of the product. The new value must be higher than the old value or the new cost less than the old one, i.e.

New value > Old value

or

New cost < Old cost

The performance evaluation of value engineering is determined by the extent of increase in value or decrease in cost.

This is given by a term called 'value ratio' given below:

$$\text{Value ratio} = \frac{\text{New value}}{\text{Old value}} = \frac{\text{Old cost}}{\text{New cost}}$$

where quality remains unchanged.

Therefore, value is increased by increasing the quality, by reducing the cost or by doing both. This is possible through logical analysis of functions of the product and sub-systems, through the application of scientific methods. Such a process to increase value of product and/or services is called value analysis.

Also there are two terms which are interchangeably used namely Value Engineering and Value Analysis. But there is a define distinction between these terms.

Value Engineering is associated with a new product or project that is being designed. It analysis the cost of the same as it is being developed. On the other hand, Value Analysis deals with an existing product or project.

It is perhaps desirable at this stage to compare value engineering with industrial engineering which are two distinctively different terms. The difference between these two terms are being systematically brought out in the following table.

Industrial Engineering	Value Engineering
Intrinsic	Extrinsic
Focus is on the production of a product	Focus is on the use of a product
Manufacturing of product is taken for granted	Questions the necessity of manufacturing the product
	Examines the design, utility & value
Examines only the best process to manufacture	
Leading to the best	Leading to the make or buy decision
Concerns with producer	Concerns with consumer
Reduces the cost of production	Reduces the cost per unit value

What Value Engineering is not?

Value engineering is not just a cost-cutting method. In the minds of many individuals, cost cutting means attacking things, as they are to reduce their cost. Value engineering, on the other hand, is a more fundamental approach that takes nothing for granted and studies everything about a product including the existence of the item itself. The only restriction is that the required functions and performance must not be worsened. In fact, useful improvement to performance can justify added cost in value engineering since this may result in an improvement in value.

Value engineering does not replace good design engineering, production engineering, work simplification, operation analysis or work study. Value engineering can and does draw on all available techniques to help in defining functions, developing alternatives and providing them.

Value Engineering, when applied in the purchasing area is different from value engineering applied in design or production. This misconception has many variations, all on the central theme that value engineering varies with the area of application. Actually, the basic elements of value engineering are the same, wherever applied.

Some practitioners seem to imply that value engineering (or value analysis) in purchasing consists of such actions as finding and developing alternate source of supply, seeking out specialty vendors, using competitive bids to lower the cost of purchase, etc. These are all aspects of good purchasing practice-not value engineering. Value engineering can be applied in purchasing either directly by applying value engineering to purchased products or indirectly by requiring that vendors do the value engineering effort by alternatives and supplying price data, etc.

Note: Wherever applied, value engineering must not be confused with other necessary functions in product design, development, testing, production and purchasing.

Value engineering is a re-appraisal of a product design, both from a function and cost standpoint, done in order to assure maximum value, using

more recent knowledge of economic environment from that of the original design engineer. Where the design group is primarily concerned with achieving the required function, the value engineering team (which includes design) is concerned with achieving the defined functions at lowest cost.

1.2 HISTORICAL BACKGROUND

Value engineering concept was developed in the General Electric Company and its origin dates back to World War II. The person who conceived the program is Lawrence D. Miles, an electrical engineer by profession.

During the second World War, one of the most serious problems faced by companies engaged in the war effort was the storage of materials. All the raw materials used by GE such as steel, Aluminium, Copper, Bronze, Nickel and Tin as well as the electrical components used in the assembling process had been diverted for war-related consumption. This put Miles and Erlicher under lot of pressure.

Miles was cost conscious and was always concerned about the high cost of several projects. He was assigned to the purchasing department and was ably guided by Harry Erlicher, the Vice-President.

This led to experimenting with substitutes, quite often in very unorthodox ways. There wasa serious effort made to try substitute materials. In many cases, the experiments clicked and surprisingly On several occasions, the team found to their astonishment that the function was performed better by the substituted materials at a lesser cost.

If it had happened on a few occasions it could have been ignored. But it was observed that when circumstances compelled than to discontinue the usual course, the result was a different design or a different material which in turn, lead to superior performance at lesser cost.

Erlicher and Miles were determined to continue their efforts even after the end of the war. They inferred that people had to be pushed out of their comfort zones had to make unusual efforts. Efforts to change design or material were made mandatory, even when materials were available. The objective of all these efforts, which were made between 1947 and 1942, was to reduce the cost.

As the efforts were taken to reduce the cost, other aspects such as the safety of the product, the durability, the aesthetic appeal,. sale ability etc., were

also added to broaden the scope of the exercise. Such a program developed by Miles was named value analysis.

Since aspects other than cost reduction were also aimed at, the participation of people with different functional expertise became a must.

To meet this need, a multi – disciplining team was constituted in General Electric Company. In 1952, for the first time, value analysis seminars were conducted.

The Team effort was an instant success. Each department was immediately aware of the impact of value analysis. The programmed was a success and it started to spread from General Electric company to other companies. Lawrence D Miles contribution to such a programmed from the scratch had earned him the title "Father of value Engineering".

L.D. Miles defined VA "as an organized creative approach which has for its purpose the efficient identification of unnecessary cost i.e. cost which provides neither quality, nor use, nor life, nor customer features." VA was traditionally used in the area of hardware projects but is now a day applied in software projects too. In non – traditional areas like customer service plans in banks, slum development, motivational techniques, VA can be of great use.

Harry Erlicher, the Vice president of purchasing, General Electric Co (U.S.A.) entrusted this job to a team of engineers headed by Lawrence Miles. In fact it was Miles who coined the term value analysis and its synonym, Value Engineering. This team under his stewardship pioneered this technique and perfected it and, it is said , saved their company 200 million over a period of 17 years. In America, the technique is very widely used and is given a great deal of importance.

In fact, the US Defence Department insists that Value Analysis should be applied in all contracts in excess of $ 1.00.000 Mr. McNamara is on record as having said that in the year ending July 1965, the Defence Department saved $ 4.6 billion by using Value Engineering "without any adverse effect in our strength combat readiness".

Navy Bureau of ship was the first organization to use VA in 1954. VE programs came in vogue in many companies of the US, UK and Japan. In India, now we have Indian Value Engineering Society (INVEST) to create awareness.' Of this approach and propagate this concept.

The US Navy was the first among the outside organizations to implement Value Engineering. It was soon followed by the US Army and Airforce.

The suppliers to these armed services were the next to adopt VE practices.

In 1958, the Electronic industries Association formed a committee on Value engineering, under the chairman ship of Miles, the committee organized many National conferences in USA. Later a society was formed and was named society of American Value Engineers (SAVE) in the year 1959.

L.D. Miles, the father of this concept, wrote in 1961, a book titled Techniques of Value Analysis and Engineering. Annual conferences were conducted and these were attended by delegates from foreign countries. Thus Value Engineering Programmers had spread throughout the world.

Based upon the success that GE experienced, numerous other companies, governmental organizations adopted the new discipline as a means of reducing costs. The first organization to initiate a formal VE programmer was the U.S. Navy Bureau of ships. In 1954, the Bureau invited Larry Miles and Roy Fountain (also of GE) to help them set up a programmer to reduce costs. Since World War II, the cost of ship had nearly doubled. The programmer name was changed to "Value Engineering" (VE) to reflect the emphasis on engineering in the Bureau of ships. This term is used almost universally in the industry today. VE was very successful and eventually a VE group was organized in organizations in various industrial and government organizations.

Check Your Progress

1. What is value engineering?
2. What is value analysis?
3. List the objectives of value engineering activities.

The form that the value engineering function will take largely depends on the size of the company the industry to which the company belongs, product mix and profitability. Many companies have a full-fledged Value Management (VM) department and others engage them on part-time basis. For example, Matushita and Hitachi in Japan, RCA, General Electric and Westinghouse in the USA, Airbus Industries in France, De Havilland in Canada, etc. have full-fledged VM departments. Many Indian firms have also taken action towards this. Examples are MECON, Ranchi, HAL, Bangalore, BHEL etc.

1.3 BENEFITS FROM VALUE ENGINEERING

VE serves all branches of an organization and focuses the attention of all on the one prime objective: equivalent performance at lowest cost. It involves a systematic consideration of alternative methods of accomplishing required functions, and of alternative materials, processes, and abilities of specialized vendors. Consequently, although VE was developed for the purpose of identifying and eliminating unnecessary costs, it is frequently responsible for a number of additional benefits, as mentioned below:

Benefit	Definition
Reliability	Ability to meet performance requirements for a determine number of times.
Maintainability	Relative ease of repair or replacement.
Productivity	Relative ease of repetitive manufacture.
Human Factors	Acceptability of change related to necessary education or dexterity.
Parts Availability	Relative ease in obtaining or manufacturing simplified or standard parts.
Production Lead Time	Elimination, standardization, or simplification of operation of materials.
Quality	Characteristics of parts to meet everything specified consistently.
Weight	Lighter in weight.
Logistics	Quantity and complexity of parts needed for field support of end items.
Performance	Ability of the changes to carry out the intended function at the time of initial test or qualification.
Packaging	Relative ease of protecting parts until ready for use.

In 1965, the US Defence department identified the scope of saving of value engineering in different area as follows:

Technology = 23.3%

Importing design = 14.8%

Removing deficiencies in design = 3.7%

Feedback from test/use = 4.0%

Over specification = 17.7%

Adapting to users' needs = 11.8%

Changes in process = 22.2%

Others = 2.5%

Economic prosperity of a country is achieved through rapid industrialization. Industrialization is possible by making products internationally competitive. In order to be successful in the international market, the product must

excel in three areas: viz. Price, quality and technology. The experiences of Japan, Korea, Taiwan, Switzerland, Holland, Denmark and others have proved that through innovation and creativity even small countries can challenge the industrial giants. These countries have given emphasis to value engineering which is one of the main reasons for their success. Price advantage is best achieved through reduction in cost of materials. Indian products are not competitive in the global market mainly because of price factor. Hence the need to cut down costs is the most important aspect for Indian industries. This is also true of most of the developing countries in the Third World. By cutting down the cost of production we are able to provide highest value for the money to the customers. This value consciousness is the underlying principle of value management. There is overwhelming evidence that one cannot practice these techniques without proper training. Training is also necessary because though the rules appear simple, interpretation of the same, and application of such rules in real life situations is complex. Rules may be easy to learn and assimilate, but it needs special ability, ingenuity and creativity, to master them. Value management is not confined to industries alone. It is equally applicable to business, industry and even in government departments.

There are several direct and indirect benefits which can accrue from the introduction and practice of Value Analysis. Some of these are:

(1) A reduction in cost of existing products or systems.

(2) Prevention of unnecessary cost in new products or systems. These two are quantifiable and can be easily measured.

(3) The introduction of Value Analysis leads to overall cost consciousness and a general attitude change toward costs.

(4) Product Value gets improved and the quest for new materials and processes, get encouraged; it provides a great boost for import substitution.

(5) Systems relating to cost and estimating usually benefit from reorganization necessitated by the wider use of cost information.

(6) Finally, a greater return of investment results. In other words, greater profits accrue and

(7) Value Analysis is a very important tool in contracts, and it is good to have a VE Incentive Clause to encourage a contractor to reduce the costs. There could be sharing of resultant benefits in a fair manner.

Originally Value Analysis technique was thought to be applicable only to engineering industries. But now it has spread to other fields. Some of the success stories are listed here. Many firms in India and abroad have a full fledged VM department. In India, Many companies like MICO, L&T, BHEL, Crompton & Greaves, TELCO etc., have full time VM Experts. For Example, in 1978, MECON located at Ranchi, applied VM in their stationary forms and reported a saving of 30% cost and also saved time of filling the form and redundancy.

1.4 SUMMARY

Value Engineering is a multidisciplinary team effort to identify and remove unnecessary costs while maintaining the performance and the reliability at the same time. Value Engineering (VE) is the process of determining the value of a product and/or service during various stages of the product life-cycle (PLC). Value analysis aims at a systematic identification and elimination of unnecessary costs resulting in the increased use of alternatives, less expensive material, cheaper designs. The basic objectives of value engineering activities are reduced cost without reducing quality, increased value without increasing cost and increased value for the given cost.

Originally Value Analysis technique was thought to be applicable only to engineering industries. But now it has spread to other fields. Many firms in India and abroad have a full fledged VE department.

Check Your progress

4. What is value ratio?
5. List the benefits of value analysis.

1.5 ANSWER TO CHECK YOUR PROGRESS

1. What is Value Engineering?

   Value Engineering is a management technique that targets the best functional balance between the cost and the performance of a product or project without compromising the reliability of the same.

2. What is Value analysis?

   Value analysis aims at a systematic identification and elimination of unnecessary costs resulting in the increased use of alternatives, less expensive material, cheaper designs, less costly methods of manufacturing etc. to provide the same performance, quality and efficiency and in a decrease of overall unit costs and consequently greater profits.

3. List the basic objectives of value engineering activities.

The basic objectives of value engineering activities are:

- Reduce cost without reducing quality
- Increase value without increasing cost
- Increase value for the given cost

4. What is Value ratio?

$$\text{Value ratio} = \frac{\text{New value}}{\text{Old value}} = \frac{\text{Old cost}}{\text{New cost}}$$

5. List the benefits of Value Analysis?
    - Reduction in cost of existing products or systems.
    - Prevention of unnecessary cost in new products or systems.
    - Overall cost consciousness
    - Product Value gets improved
    - Greater profits accrue.

CREATIVITY AND ITS ROLE IN VALUE ENGINEERING

NOTES

2.1 INTRODUCTION TO CREATIVE THINKING

Realizing the potential benefits and the factors that influence the effectiveness of creativity will help improve our overall understanding of the subject. The goal is to outline ways to employ the concept in a useful and effective manner.

Creative thinking is often associated with the development of a new thought or idea or concept that has not been thought of before. Einstein's theory of relativity was a new concept. Likewise, discovery of uses for electricity can also be termed a new concept. Another definition of creative thinking is that it is a product of the imagination where a new combination of thoughts and things are brought together. We have found the latter to be the best definition. The key word is "combination."

Frank Lloyd Wright, America's renowned architect, was unquestionably a creative individual. His designs were unique at the time of their development and yet the materials used in his designs were readily available on the commercial marketplace. Concrete, timber, steel and masonry designs were proven techniques at the time. It was the combination of these materials and techniques that made Frank Lloyd Wright a renowned architect.

An excellent example of a new combination was the development of gunpowder. In 1242, Friar Roger Bacon of Oxford University published a book on how to make gunpowder. The ingredients of potassium nitrate (saltpeter), carbon and sulphur were known elements. What was not known was that if one combined these elements and ignited them, an explosion resulted. By changing the proportions, the force of the explosion could be controlled.

Creative techniques are used to bring about improvements and progress. Creative thinking may be seen as a means of overcoming problems that confront us. The solutions, our creative ideas, are often new and different from the original designer's concept. There is always a new proposition that improves the required function. Even if the basic premise is sound, there are always methods to improve that concept. When a project is value engineered, a good design is made more cost effective. The options are unlimited. Finding the best solution is where the challenge occurs.

2.1.1 Creative People

The capacity to be creative is likely a congenital trait. The actual creativity of an individual develops throughout his life with trail and error. Creative ability is nurtured from birth, and is in constant development throughout adolescence and into maturity. This is contrary to the old belief that only geniuses, or persons with a very high I.Q., possess the ability to be creative. Albert Einstein, Thomas Edison and others were considered creative individuals because they were geniuses of their time. However, we now recognize that each individual has a certain amount of creativity within his own psychological makeup. We all know that architects, engineers and managers, to name a few, express their creativity by way of their designs and their ingenuity in managing a company. Creativity and high intelligence do not necessarily correlate. Individuals of high intelligence may be restricted to the point where their creativity and judgment are curbed.

Psychologists have studied the relationship between I.Q., and creativity. There is a diversity of opinion regarding the connection of high I.Q. and the

amount of creative ability possessed by an individual. One thing is definite, however, and that is that everyone has some creative ability. Unfortunately, roadblocks traditionally get in the way of the development of a person's inborn creative talent. The influences of home and school often thwart the child's creative drive by not allowing him to experiment. The rules are often too rigid and inflexible.

Parents must learn to strike the proper balance between necessary discipline and an open educational environment. Finding the proper balance is certainly not an easy task.

Establishing an open environment to allow an individual creative capacity to develop is also a goal of the value engineering study. Let's look at some examples of creativity in our everyday life. A housewife must provide a plan for stretching her budget for feeding and clothing her family. As living costs continue to soar, she must devise new ways of stretching those dollars. Another example is the person who buys an old rundown hose and uses his creativity to renovate, redecorate and reconstruct the house into a beautiful picture of architecture. Another example would be a minister who must divide his time between preparing and preaching a sermon and looking out for the welfare of his congregation and at the same time must also develop plans to increase attendance. It is becoming apparent that creativity is used every day in our lives, and that creative individuals are not a part of one group.

In value engineering, we are interested in the creative capability of individuals, as this is one characteristic that is necessary to a value engineering team. Bringing out this creative ability is the key task of the value engineering specialist.

Let's explore the subject of who is a creative individual. Several different types of people have been identified as creative individuals:

1. Small children: The ingenuity and imagination of a child are almost unlimited. Parents, especially, wonder how their children can have so much imagination at the age of two, and how they can get into so much trouble.

2. Scientists: Scientists are creative individuals because their jobs provide a forum for new combinations of chemicals, new properties of materials and new discoveries with which to perfect and to improve our existing products.

3. Pioneers: The early pioneers in our country and in other countries had to be creative in order to survive. They faced adverse weather conditions

and a fear of the unknown. It was often their creative imagination and ingenuity that helped them to survive their ordeals.

4. Seabees: The Seabees were organized in World War II as the construction division of the U.S. Navy. While building in the jungles of Guam, the Seabees invented the chain saw that we now use in our homes today. They also invented the steel mesh that was used to build runways and roads for supporting vehicles in marshy, wet areas. Many of their discoveries were based on necessity.

5. Writers: Writers must be creative individuals. The writer must be able to express himself in new combinations of words and thoughts in order to express ideas and concepts to the reader.

6. Housewives: Several years ago, in a parking lot in Schenectady, New York, one of the authors observed a woman who was returning to her car after shopping. There were several inches of snow on the ground and very severe ice conditions. After the women got into her car, she started the motor and began to back out of the parking space. The ice was very slick and the wheels began to spin. She reached into her grocery bag picked out a box of graham crackers, pulled out the crackers, crunched them up, and threw them under the back wheels of the car. She then got back into the car, put the car into reverse, pulled out of the parking space and went on her way. She had developed a new combination to solve her problem.

7. Architects: Each new building or interior design is a new combination of materials, colours, space allocations and physical conditions. The verity and integrity of our buildings and structures are excellent representation of the creative capacity of our architects.

8. Engineers: Engineers, like architects, need a variety of materials, principles and properties to arrive at their designs. Pre-stressed concrete, for example, was virtually unknown 20 years ago. The concrete and reinforcing steel used in pre-stressed concrete were all materials that were previously available. However, the new process of pre-stressing the reinforcing steel involved a new combination of processes which has resulted in substantial savings to building owners throughout the country.

Judgment is a factor that affects the acceptance or rejection of creative ideas. Often, people of high intelligence will attempt to block an idea with little consideration of the facts. Slightly over 100 years ago, in 1878, Alexander Graham Bell offered the new invention, the telephone, to the president of

Western Telegraph for $25,000. The president responded that he had no time to waste on toys that they already had a communication system in the telegraph, and the telephone had no practical value. The president was a man of high intelligence, but his judgment in this instance was certainly poor.

In other words, if you have a great idea, just because a highly intelligent or high-positioned man tells you its no good does not mean necessarily that he is right. In a televised interview, Howard Jarvis of California Proposition 13 fame, related the following story. He was advised by a banker he had consulted several years ago not to buy land that was for sale at 17 1/2 cents a square foot in a California coastal town, as it would never be worth much more because of its poor location. Jarvis said he felt the bank official should know about land values, hence he decided not to buy the property on the banker's advice. As he walked out of a store and down the street, he saw a sign on a hardware store identifying carpeting for sale at 19 1/2 cents a square foot. Jarvis thought, if that carpeting is worth 19 1/2 cents, the land certainly should be worth more than the carpeting and that the banker must be wrong. He purchased the land, and made $100,000 profit when he sold it. The morals: gather all the information you can, but in the final analysis use your own best judgment and not someone else'

2.1.2 Characteristics of Creative People

When staffing a value engineering study, we look for creative individuals. It becomes important to know the characteristics of creative people in order to select the best team members for a value engineering team. We know that everyone possesses some degree of creativity; however, we are now looking for individuals who are ready to put their creativity to work.

We believe that the prime thesis behind creativity is that the individual must believe that it can be done. This is taken from a book written by David J. Schwartz, entitled The Magic of Thinking Big. Believing that it can be done is often half the battle in finding the solution. If a person believes that something can be done, it will also activate his mind to seek ways that a solution can be found. On the contrary, if a person believes that the task is impossible; his mind will shut out potential solutions that may be valuable. Some people call this task "mind-tuning," or developing an appropriate attitude before entering into the problem-solving techniques.

Because value engineering is a proven technique, we know that better value will, in fact, come as a result of our value engineering studies. As value

engineers, we believe that there is potential for removing unnecessary costs in any design or any process or project.

In this context, creativity in an individual may be manifested as active into the design process. Another person may have latent creativity that is waiting for an opportunity and a situation in which to express itself. The following characteristics have been found to be representative of creative people. However, they are certainly not the only characteristics with which to judge a creative individual.

1. Motivation: First, they must have a desire to find a better solution for a project. Motivation is often expressed in enthusiasm for the challenge of attacking a new and complex project. People who are highly motivated will push themselves and the members of their team to go beyond their normal habit solutions,

2. Flexibility in thinking: It is difficult for a civil engineer to make comments and suggestions on a mechanical design. The civil engineer often believes that his background does not give him the experience to make suggestions on other areas of the project. In value engineering, engineers should not be reluctant to consider alternate approaches that may be a new and creative. Many of the best recommendations come from people outside of their particular field of study. As an example, the pneumatic tire was invented by a veterinarian. A person must also be flexible in his and more effective information.

3. Sensitivity to the problem: A person must have an awareness and a feel for the problem areas. For value engineering on construction projects he must have a perception of where the high-cost areas are in the project, and be able to spot the areas where improvements can be made. Our experience in value engineering on construction projects has shown that certain people can zero-in on the high-cost areas of a project in a short time. They have a perception and a feel for the' cost being paid for the required functions.

4. Originality: A creative person is able to come up with new and original ideas. He has a wide span of interests from which he can draw. He is able to combine ideas suggested by other team members with his own experience in an effort to improve the final product. The original thinker is an inquisitive I individual who is unwilling to accept the statement, "we have always done it this way," as being a logical solution.

5. Persistence or drive: Emotional drive is the motivating force that

helps us overcome adversity and roadblocks that we face when coming up with new and creative ideas. We have talked about the subject of roadblocks in the chapter entitled, "Habits, Roadblocks and Attitudes."

6. Openness to change: The creator or innovator brings about change to our society. Resistance to change is often a stead fast thing in many people's minds. They are unwilling to take the risk that could result in failure. On the other hand, if there were no risk, there could be no change,

7. Ability to abstract: The field of engineering is based upon absolute principles and properties. There is very little abstract thinking that goes into our designs. They are primarily based on material properties, proven strength and scientific knowledge. Developing new ideas that are as yet unproven is not something that an engineer is used to doing.

8. Tolerance of ambiguity: In a value engineering study, we are often unsure whether our creative ideas will, in fact, be developed and eventually be recommended. What one undergoes is a reluctance, at times, to suggest ideas without having a clear cut, positive notion that the particular idea is , in fact, a better recommendation. There is always some ambiguity in coming up with a creative idea.

2.2 CREATIVE PROCESS (TOOLKIT OF CREATIVITY)

The creative thought process is composed of three main categories: imagination, inspiration and illumination; these three creative processes were obtained by analysis of how creative thought comes about. If you were an inventor, such as Thomas Edison, the Wright Brothers, Henry Ford, Charles Kettering, or others, you would likely use this toolkit of creativity..if you were a song writer, a painter, a housewife. teacher, statesman, writer. etc.., you would likely use the same toolkit. In other words, there is no difference in the toolkit, the difference lies in the application.

Imagination

Einstein once said that "imagination is more important than knowledge." It is interesting to note that he did not say that imagination was as important as knowledge; he stated that it is more important than knowledge. A good example of Einstein's thesis occurred at the turn of the century. Dr. Simon Newcomb, a leading scientist at that time, published this statement: "The demonstration that there is no combination of force or machinery that can be put together by which men shall fly is as, conclusive as anything could possibly be

"About the same time that this statement was made, two very intelligent bicycle mechanics, were enthusiastically working on their mechanical bird with manmade wings. They did not know all the theoretical principles of aerodynamics but they constructed a wind tunnel and collected information about shifts in the centre of gravity and resultant lift on the airplane wings. They conceived the idea of varying the inclination of sections of the wing to aid in controlling the plane. The part is the aileron. They enthusiastically worked on their mechanical bird; and we all know what happened from these two bicycle mechanics in December of 1903. Their imagination and their persistence brought about the first successful powered flight. Perhaps that is what Einstein was talking about when he said, "imagination is even more important than knowledge."

Enthusiasm and imagination go hand in hand. It is our enthusiasm which drives our imagination to endless limits. Ralph Waldo Emerson once observed that nothing great was ever achieved without enthusiasm. It is the key to our imagination is at its peak when our enthusiasm is in full swing. Imagination is a deliberate process that works in direct proportion to one's enthusiasm and does not seem to work if enthusiasm is not present.

Inspiration

Inspiration is a factor that is brought on by accidental stimuli. Knowledge and experience are often available but need some new elements that will trigger a new combination. We all, at times, receive inspiration from the people that we come in contact with, by our exposure to new ideas that are parallel to our own and by contact with ideas that are a contrast to our proposed solution of a problem, or by some adjoining thought.

An excellent example of an inspirational discovery occurred in 1942, during World War II, in England. The Royal Air Force was charged with the destruction of three hydroelectric dams that supplied hydroelectric power to the Ruhr Valley, which produced much of the Nazi war machinery. Prior attacks had been made on the dam without noticeable result. Dr. Barnes Wallis came up with the idea that a 500-pound bomb could be dropped, not on top of the dam, but behind the dam, so that it would skip along the water. When it hit the dam wall, it could be stopped without bursting and sink straight down the side of the wall and be detonated by the water pressure. The explosion would combine the force of the power of the bomb, the pressure of the water and the containment of the explosion by the 'more' dense water com-

pared to the air above. These three forces would be sufficient to rupture the dam wall. Prior attempts at bombing the top of the wall had failed. The problem was, how to drop the bomb so that it would skip across the water at the correct velocity. It was determined by experimentation that the bomb must be dropped 600 yards in back at the wall at an altitude of 60 feet above water level. The distance from the dam wall was easily determined by a sight-gage mounted on the airplane's window. The sight-gage would be lined up with the dam spillway. There was, however, no solution for determining a precise altitude of 60 feet above water level. One solution was a plumb bob suspended by a piano wire. Others were tired, but were unworkable. There must be a way without redesigning the altimeter itself. Guy Gibson was attending a night club show in downtown don one evening. The show was at the famous Windmill Theatre, whose motto was "we never close." They operated through the London blitz. As Guy Gibson was watching the show, he observed that the spotlights focusing on the female performer sometimes combined into one spot, and sometimes two. He turned to view the two corners of the theatre, and noticed there were two spotlights, each focused on one location. An idea materialized! Why not place one spotlight in the left wing-up and another in the right wing-tip, and position them so that at exactly, 60 feet above water, only one spot would show. Guy Gibson was inspired by an accidental stimulus of spotlights crossing on the stage.

One light was placed in the nose, and the other in the tail. Nineteen airplanes were sent on that raid. Eight were shot down. Fifty-six men were killed, but the RAF destroyed the Eder and the Hoehne dams. Forty-two factories were wiped out from the tidal wave alone.

Illumination

Illumination is what happens when the idea about a project you have been working on simply arises from your subconscious to your conscious mind. Illumination is brought about by the addition of new information that enlightens us in alternate ways of performing the same function. James Watt's development of the steam engine condenser came as a result of illumination. He had viewed the model of a cylinder with a piston. Heat was introduced into the cylinder, pressure in the cylinder would build, and the piston would be pushed out. Cold water was then injected in the cylinder, and the pressure inside would drop, causing the cylinder to be returned. The potential for work was obvious to James Watt. If only they could make it move faster. The in and out action of the cylinder was too slow. Watt worked for several months

trying to resolve his problem. According to Watt, he was-enjoying a relaxing day walking home from church, when suddenly it popped into his mind that steam was an elastic body. Why not save the elastic steam in a condenser and have two units working in tandem. Details for the design falling into plate. He could hardly wait to get home to his design board to record and sketch his thoughts. His conscious mind had not been thinking of the problem. However subconsciously he had been working on the solution. We bring up these three examples of the creative thought process to make the reader aware of his potential for creating and developing new and exciting ideas. Each individual is stimulated in different ways to bring about new concepts.

Problem Solving Methods

There are two approaches to problem solving: the analytical and the creative.

The two approaches are discussed below.

a) Analytical Approach

The strictly analytical approach is substantially singular in purpose. The problem is stated exactly. A direct approach to the solution is taken, proceeding through a step-by-step progression of experiments, evaluations and mathematical manipulations to arrive at a single answer. An analytical problem is one that frequently has only one solution that will work.

b) Creative Approach

The creative approach is used when there appears to be either no solution or more that one solution to a particular problem. The creative approach is an idea producing process intended specifically to generate a number of solutions, each of which will solve the problem at hand. All solutions will work, but one is better then the others; it is the optimum solution among those available. The best solution to the problem may not even have been generated.

2.3 CREATIVITY IN VALUE ENGINEERING

Successful application of value engineering (VE) requires the use of creative problem solving techniques. It takes creativity to innovate alternate designs, systems, methods or processes that will perform the necessary function at the lowest possible cost.

Creative application in VE is directed toward achieving best value. The finding of the best ways to achieve value in product design is the engineer's

most important problem. He should ask himself the following questions concerning the product:

1. What is its required function?
2. What alternative ways can the necessary function be performed?
3. Which of the alternative ways is the lowest overall cost of ownership?

NOTES

Steps in the Creative process

To give a greater understanding of the nature of creativity, we need to study the creative process. The process follows a step-by-step sequence in the solving of problems. However don't conclude from this approach that innovation or creativity is always the result of conscious or even logical effort. The creative process is that process which the mind follows in seeking the solution to a problem. It follows these steps:

1. **Orientation:** Defining the problem to be solved and selecting the approach that should be taken to solve it.
2. **Preparation:** Information-gathering and fact-finding.
3. **Analysis:** Evaluation and analysis of the data gathered.
4. **Ideation:** Production of alternative solutions to the problems.
5. **Incubation:** Sorting and combining the information (slowing the pace to invite illumination).
6. **Synthesis:** Bringing all the ideas together into a complete whole.
7. **Verification (Evaluation):** Evaluation of the proposed solution or resultant ideas.

Creativity Techniques

There are a number of creativity techniques available for problem solving situations. Some of the more generally ones will be discussed. Some are for use by individuals working alone and some intended for use by groups, some of these methods were created for application to particular categories of problems, some for problems peculiar to one type of organization, and some for creation of skill levels of the personnel who will use them. All the techniques provide a method or mechanical procedure to help the user generate more solutions to his creative problems.

The various techniques provide formats for mental stimulation-it is necessary, during their usage, to conscientiously think creatively. The ground rules to be followed may be summarized as:

1. Do not attempt to generate new ideas and to judge them at the same time. Separate these aspects by time, by place, and by different personnel, if possible.
2. Generate a large quantity of possible solutions. Multiply the number of ideas produced in the first rush of thinking by 5 or by 10, to set a goal for the desired quantity.
3. Seek a wide variety of solutions that represent a broad spectrum of attacks upon the problem.
4. Watch for opportunities to combine or improve ideas as they are generated.
5. Before closing the book on possible solutions, allow time for subconscious operation on the problem while consciously performing other tasks.

The two basic rules for the use of creativity technique are:

1. All judgment or evaluation is eliminated from the idea producing stage.
2. All ideas, even the most impractical, are considered.

"The elimination of judgment from the idea producing stage rule allows for maximum accumulation of ideas. It prevents the premature death of a potentiality good idea and conserves the time of the group or individual working on the problem by preventing shifts from creating of original ideas to evaluation of the ideas. Consideration of all ideas encourages everybody to explore new areas even those that seem impractical. This rule gives the innovator the opportunity to express thoughts he might be reluctant to voice under ordinary conditions for fear of ridicule."

Creativity techniques fall into three categories, namely:

1. Free Association Techniques: In these, strong emphasis is placed upon association. Two major techniques in this category are:
   (a) Brainstorming.
   (b) Gordon techniques
2. Organized Techniques: These are characterized by a logical step-by-step approach. techniques in this category are:
   (a) Checklists.
   (b) Morphological analysis.

(c) Attribute listing.

(d) Input-Output technique.

3. Forced Relationship Techniques: These techniques operate on the principle of forcing a relationship between two objects or ideas which have never been previously associated. The forced relationship techniques are of limited value and are seldom used in VE.

2.4 PSYCHOLOGICAL BASICS OF CREATIVITY

Aristotle gave us these three basic elements of the association of ideas under three laws of creative thinking:

1. Similarity –or like ideas
2. Contiguity –or adjoining ideas
3. Contrast –or opposite ideas

Similarity

What do we mean by similarity of ideas? Again, the example of similarity of ideas can be found in the development of the typewriter. The typewriter is designed similar to the piano. If a man or woman could sit down to a piano keyboard and select the notes desired to play a certain melody, then certainly they could sit down with a similar keyboard of the alphabet and select the letters to develop words and paragraphs.

Another example of similarity of ideas may be found in the wastewater field. Composting is a relatively new process which is used to stabilize wastewater sludge so that they may be placed back on the land and used for soil conditioners. The process used in composting is very similar to the process that nature uses in the bacteriological breakdown of decaying organic matter. The composting process modifies and speeds up nature's process.

Contiguity

Contiguity is the process of the association of adjoining ideas. When you look up and see a cloudy sky, the adjoining thought that you have is that it might rain. Louis Pasteur, in his development of the inoculation process, is a good example of contiguity. Louis Pasteur had been experimenting on the development of a cure to combat chicken cholera. In the middle of the experimentation, Pasteur became ill and was forced to go to bed. Pasteur had been using chickens in his experiment. He asked his landlady to care for his chickens and cholera bacteria. She agreed to feed the chickens but refused to touch the cholera culture. Thus the germs became weak. At the time of his illness he

bad divided them into groups: one with severe chicken cholera, the second, with mild cholera, and the third, a group that had never been ex-posed to the disease. He had also been successful in isolating various cultures of chicken cholera. Pasteur observed that some of his chickens survived cholera that previously had been severely ill with the disease, while others that had been exposed to mild cases, survived. Once they had had either a mild or a severe case of cholera, they never contacted the disease again. He suddenly thought of his weak chicken cholera cultures and wondered if, by introducing the weak germs into the chicken which had never been exposed to cholera, it would build immunity within them. Thus, inoculation was born. What was the main process or association of thoughts? It was contiguity.

Contrast

The third law, contrast, obviously means the opposite idea. We use contrasting thoughts and processes everyday in our designs. A good example is the design of highways. To provide a smooth ride and save on fuel consumption, highway designs strive for straight roadways with minimal slopes. On dangerous curves, the chance of losing control because of skidding is a potential hazard. The skidding occurs because there is not enough friction between the road surface and the vehicle wheels. On dangerous curves, highways are now being constructed with special aggregate material that is sometimes grooved to increase the friction of the paved surface and aid in stopping the vehicles. The opposite idea of increasing the friction of the smooth paved has helped to save the lives of many of the nation's motorists.

Another example is in the design of building structures to counteract buoyancy. We counteract buoyancy by adding extra weight to hold the structure down. It is an opposite reaction to the buoyant force.

Pennsylvania was one of the earliest states to have a railroad. They experienced a plague of grasshoppers while ascending a steep grade. The wheels on the mighty steam engine began to slip on the rails which were made slippery with crushed grasshoppers. They themselves what was the contrast to the slippery grasshoppers. Someone mentioned sand. A sandbox was installed high on the engine with pipes running to a point in front of the wheels. A slight amount of stand was put on the rails. It stopped the skidding. To this day somewhere on the modern diesel railroad engine you will still find the useful sandbox. The contrasting idea helped solve the problem.

2.4.1 What Stimulates Creativity?

What prompts us to go beyond the normal solutions to problems? For people who are creative thinkers, traditional thinking can be one of our worst enemies. It freezes our minds. It blocks our creative thoughts and prevents us from developing further.

Charles Kettering was on of the more progressive inventors of our century. Many of his ideas and inventions met great opposition when first proposed. Kettering made his observation about the development of new ideas:

"Man is so constituted as to see what is wrong with a new thing, not what is right." To verify this, submit a new idea to a committee. They will obliterate 90 percent of the rightness for the sake of 10 percent wrongness. The possibilities a new idea opens up are not visualized because not one man in a thousand uses his imagination. Yet, faced with this adversity, progress still occurs. Let's look at several reasons and factors that motivate our creativity. We should add that many of these factors came from participants in our 40-hour value engineering workshops.

1. Search for beauty: This factor was added to our list at the request of an architect. Architects are continuously looking for beauty in their structures as an enhancement to our environment.

2. Discontent with status quo: Creativity is spurred on by an unwillingness to accept the statement that design is optimized to the fullest extent. Constructive discontent is a good example of this principle. American industry would soon fail if they thought that further improvements were impossible. Successful businesses live with the question of how they can improve the quality and performance of their products. Because we are human, all of our designs can be improved. Optimum balance cost, performance and reliability can always be improved.

3. Wars: Wars are placed on the list for subjects that motivate creativity because many new inventions have come out of desperation of war. Such inventions are bred out of necessity.

4. Ignorance of the past: So often, if you don't know that something can't be done, you go ahead and try to do it anyhow. Often, Knowing too much about the problem will discourage you from further investigation. Charles Kettering had a system that he used in these situations. If he had problem that dealt with chemical composition, he would assign it to two people. He would assign one man 'with a strong chemical engineering education, and another

Check Your Progress

1. Define creative thinking.
2. List the steps in creative process.

individual who was not educated in the field of chemistry. He would keep them separated while they were working on the problem.

Many times, the chemical engineer would come up with the better solution. At other times, the fellow who had no education in chemical engineering would come up with a better solution because he was viewing it from a different direction.

Our past experience will sometimes lead us away from a viable solution. Not all the answers are found in the mathematical or scientific solutions that have been previously developed. It is often necessary to look beyond our own area of expertise to find the solutions to a person.

5. Necessity: It is said that necessity is the mother of invention. With the change in the availability and the price of energy, we are now faced with critical problems that affect not only our ability to heat our homes and provide gasoline and oil for transportation purposes, but also the inflationary spiral of our business economy. The point where we must devise alternate energy resources has been reached. A good example of necessity is the development of our space age resources to put a man on the moon. Shortly after the Russians launched their first sputnik into outer space, the U.S. felt the need to put a man on the moon within the following decade. American industry responded accordingly.

6. Greed: Criminals and businessmen often device creative, and often devious ways to make money. White-collar crime has came to the forefront as a new way of beating the system. In this case, it gets in the way of proper judgment.

7. Curiosity: The old saying that curiosity killed a cat may be true, although curiosity and experimentation have also made men rich. A creative individual has an overwhelming desire to invent, to create and to refine. A curious person is also an individual who is not satisfied with the obvious solutions. Curiosity also leads the way for the quest for further knowledge and a further understanding of our fields of study.

8. Knowledge: It has been the experience of the authors that the more a person learns about a subject, the more he desires to further broaden the depth of knowledge in that subject. Take, for example, the bridge, designer who has a basic knowledge and understanding of loads on highway bridges, materials of construction and design procedures. That individual would be most interested in new developments in the field, new designs, new materials and new insight into construction methods.

9. Competition: Competition is what makes our society function. To be successful a company must keep up with the latest advances in technology; it must also attempt to be at the head of development of new ideas and products. An excellent example of competition is in the manufacture of hand calculators. The transistor, printed circuit boards and electronic chips now perform the same functions that tubes and other electronic gear used to perform. Competition and the development of the transistor have brought the price down substantially.

2.4.2 What Stifles Creativity?

Development of ingenious and innovative idea is a trying task. It often requires going out on limb with an idea that is a change from our norm. It requires a proper to risk the possibility of being wrong in his idea. In contrast, it is easy to stifle a creative idea. Ideas are usually stifled by individuals with a quick response. Experienced individuals, knowledgeable in the field of construction, said that the first steel framed building structure would not last became the contraction and expansion of the steel would crack all the plaster material and all that would be left would be left be the steel frame. This was a quick response and a roadblock to the development and progress of our society. Charles Kettering. Who received the award of merit of the American Alumni Council in 1948 for his work as a scientist, a humanitarian, inventor, philosopher, college graduate and an American, had two significant Points that he would often make. The first point was that guidelines that were established were often rigid and unbending. The other point was that we don't teach people the proper attitude to adopt when they meet with failure.

On the first point of making guidelines too rigid, he noted that too often people feel it because something is written down in the guidelines, there is only one way to do it. Kettering relates the story of his invention of the automatic self-starter for an automobile, and notes that the important guidelines requiring wire of a certain minimum thickness to carry a minimum current. This had been a good standard because it prevented people from improperly wiring houses, machinery and other electrical devices. Wires that were too thin or poorly insulated to carry the required current continuously heated up and often caught fire. Kettering, however, felt that they did not have his potential self-starter in mind when they set these standards. Had he chosen to use the wire size specified in the standard, the self-starter would have been almost as big as the engine. Kettering's design used wire that carried five

times the allowable current set by the standard for continuous use. His defense for violating the rule was that he only carried the current for a short period of time sufficient to start the automobile.

Kettering's self-starter was first used on a 1912 Cadillac. Shortly after, he was invited to speak at a meeting of the American Institute of Electrical Engineers. Kettering's talk centered on his development of the self-starter. After his presentation, one of the individuals in the audience stood up and made the following statement:

No wonder he can make a self-starter. He transgresses every fundamental law of electrical engineering. If you want to make self-starter that way, you are welcome to it. I'm an honorable electrical engineer, and I refuse to do that.

But, as Kettering remarked:

All human development, no matter what form it takes, must be outside the rules; otherwise, we would never have anything new.

Kettering's invention went past the normal rules were used at the time. New applications, revised guidelines and an ingenious idea made Charles Kettering's self-starter an instant success.

The second point that Kettering made is that inventors and innovators are scarce because people are not taught how to fail with the proper attitude. Often, when people fail, they meet with derision and scorn from their associates. Kettering's main thesis was that once you fail, get up and try again, and again, and again. Look for new combinations, new ways of doing things, and stretch your imagination beyond the limits of normal solutions.

The following are experts from remarks by Charles F. Kettering on receiving the Award of Merit of the American Alumni Council at Ann Arbor, Michigan, on July 13, 1948. The remarks are transcribed from a radio broadcast by Station WJR, Detroit.

Why do we always fail in these things? Well, the thing is very elementary again because the first time you do anything you're doing it as a very amateur because that's all an amateur is -a person doing a thing for the first time. And his ability to succeed on the first time would be purely accidental on anything outside of the most mediocre attempts. So this questions of practicing how to make each step.

Sometimes you have to practice, practice, practice and practice. That's the reason why we can never tell you how long it's going to be after we start

a project before you get the answer because we don't know how much practice we have to do on the road. You can call it experimentation anything you want to-research is only a word for giving failure a respectable nomenclature. That's all. It's much more difficult to reverse the thinking of people than it is to give them a new idea. We have that problem stepping up here a little bit on a new type of engine which we developed. The new type of engine is exactly like the old type, but we rearrange certain parts of this engine differently from what it's been. We went out and got the consensus of studied opinion on that, just for fun and even in our organization, where people are paid to be open minded the consensus of studied opinion was no good.

Let the job be the boss and you follow it around run errands for it and that's the way you get things done. In this thing of studied opinion, there is no possible way in which you can overcome the negative attitude or the wrong attitude to a thing by any argument, philosophy, logic, or anything of the kind. Any time you are arguing on a thing like that, you're just wasting time. The only thing that will solve that problem is a sample-a working sample.

Contentment with the status quo greatly diminishes creativity and is a threat to progress. All progress requires some change. It is our ability to manage that change that will determine its success. You can't reach second base unless you leave first.

Anything that is new or is a change is full of unknowns. A creative individual who is enthusiastic about his new concept runs into possible danger from the negative thinker who is fast to squelch any new ideas. The emphasis on the negative will quickly diminish the benefits of a new idea. Many of us have been to staff meetings with the managers of our firms. A new idea; a creative solution to lasting problem, is brought up by a staff member. Often times that new idea is met with a barrage of reasons as to why it won't work. People will not take the time to think of a reason why it will work, but will be free with their advice as to why it will not work. In today's society, we are facing more and more the problems of a bureaucratic government. A key example of stifling creativity comes in the form of contractor – incentive clauses. Contractors are given the opportunity to use their creativity to come up with innovative ways to reduce the cost of construction, which will result in saving not only to the contractor, but also to the owner. Most contractors are reluctant to submit such changes, due to the red tape and bureaucracies that they must wade through in order to get their ideas and their concepts accepted and

implemented. On construction jobs, they cannot afford the time required to implement such changes.

Mental Blocks to Creativity

There are mental attitudes or influences which serve to retard or block the creative process. These block may be catergorized as habitual, perceptual, and emotional.

1. Habitual Blocks
   (a) Continuing to use "tried and true" procedures even though new and better ones are available.
   (b) Rejection of alternate solutions which are incompatible with habitual solutions.
   (c) Lack of positive outlook, of effort, conformity to custom, and reliance on authority.
2. Perceptual blocks
   (a) Failure to use all the senses for observation
   (b) Failure to investigate the obvious
   (c) Inability to define terms.
   (d) Difficulty in visualizing remote relationships.
   (e) Failure to distinguish between cause and effect.
3. Cultural Blocks
   (a) Desire to conform to "proper" patterns, customs or methods.
   (b) Over – emphasis on competition or on cooperation.
   (c) The drive to be practical above all things – too quick to apply judgment.
   (d) Belief that all indulgence in fantasy is a time.
   (e) Faith only in reason and logic.
4. Emotional Blocks
   (a) Fear of making mistake or of appearing foolish.
   (b) Fear of supervisors and distrust of colleagues and subordinates.
   (c) Over – motivation to succeed quickly.
   (d) Refusal to take any detour in reaching a goal.
   (e) Inability to reject decisions which are adequate but which are obviously sub – optimum.

Positive Factors Affecting Creativity

On the positive side of creativity there are factors that make an individual "creative". Some of these attributes are:

1. Problem sensitivity: Being at war a problem exists.
2. Idea Fluency: Being able to produce ideas in copious quantities.
3. Flexibility: Being adaptive in the approach to a problem.
4. Originality: Ability to produce a great number of new and unique ideas.
5. Constructive Discontent: A dissatisfaction with existing conditions and an attitude of mind which seeks to improve the conditions. This type of person usually asks why and how.
6. Observation: Alertness to the environment.
7. Facility at Combination: The ability to combine and recombine information in a verity of ways.
8. Orientation: Development of the proper frame of mind towards creativity.
9. Motivation: The mustering of the necessary energy to work towards the goal.
10. Permissive Atmosphere: The environment in which new ideas are encouraged. The characteristics of a permissive atmosphere are:
    (a) Freedom of expression
    (b) Job satisfaction
    (c) Effective communications.
    (d) Mutual respect and encouragement from co-workers.

Some hints that may help develop a creative ability are:

1. Write down ideas as they occur.
2. Take notes on observations.
3. Set deadlines or quotas for creative ability.
4. Establish a specific time and place for creative thinking.

The long-term objectives of any business enterprise are expansion, growth, and perpetuity. These objectives hold striking similarity of the cosmic nature of the universe, viz. creation, sustenance and perpetuity. Modern management principles lay great emphasis on a sound organizational structure manned by component persons to ensure the above long-term objectives. These objectives are achieved through creative thinking, innovative strategies and entrepreneur-

ship in order to improve productivity " and achieve competitiveness for success. The experiences of Japan, Korea and Taiwan are some striking examples of creativity and innovation. Similar to the concept that the Creator is present every where, creativity pervades every field of management, viz. Production marketing, engineering, stores, finances, and office management. Schumpeter, defines innovation as any idea which may cut down cost of production, increase sales at same price or sell same quantity at higher price. Brown explains innovation as "the discovery of new use of old products". In terms of value engineering, innovation is – the method of improving the value of a product Innovation, in other words, make business more pleasant, attractive and profitable which will improve goodwill and increase the quality of life of the people. Creativity involves unconventional way of thinking and doing things. Both lead to novelty in thinking and doing.

Steps Towards Promoting Creativity and Innovation

Innovation is in essence a broader concept, which introduces novelties for improving design, process, methods or look. Innovation is not derived out of conventional concepts or through sophisticated mathematical formulae or models; Creative imagination is the source of all innovations. Innovations are contributed by ordinary people, not by machines, however, sophisticated they may be Here the focus is on the people.

The next question is whether creative thinking leading to innovation is an inborn quality of man or something which can be externally or motivated. If we accept the argument that creativity is something which is inborn, we will have to agree to the following hypotheses:

- The trait theory of human psychology holds good
- People born in creation parts of world like Japan are creative

Both these hypotheses are wrong. This leads us to conclude that creative thinking and innovative spirit are more induced than inborn. The following steps are needed for promoting creativity and innovation in an organization.

(a) Top Management Support

Top management must be committed to this concept and take initiative to create and promote suitable organization culture and working environment which promotes innovation.

(b) Leadership Qualities

Real leaders are good followers. They must be able to identify, encourage and develop creativity found among their subordinates and reward them suitably. A leader will not consider him self as having "superior wisdom" compared to all his subordinates. He is not a boss a martinet. He does not believe that wisdom grows out of his rank or the hierarchical position or power he holds. Such leaders must take 'no' for an answer. His subordinates must have freedom to express their views without fear or favour. A manager who has no confidence on the capability of his subordinates, or who views with suspicion a component subordinate as his 'potential rival' in the hierarchical ladder has no place in such an organization. Good leaders, in short, believe 'resourcefulness' is more important than 'resources'.

(c) Organisation Climate

Top management support and availability of managers with leadership qualities promote an innovative climate in the organization. In such an organization, each one feels himself to be important, and possesses a sense of belongingness to the organization and an urge to do something new. In such as organization, he is quite confident that his efforts will be recognised and has confidence in the fairness and equity of his superiors. Such organizations are characterized by following:

- An informal and flexible organization structure.
- Focus is on contents and production rather than on form and procedures.
- Open mindedness: and non-conservatism.
- Adequate two-way communication.
- More number of young people in the organization.
- Encourages lateral induction of persons at middle/lower levels.
- Informal relationships with each other. Often they address each other by their first name and rarely by the formal form of "sir or madam".
- Promote unconventional means and methods of achieving results.
- Here the emphasis is given not on "working harder" but on "working smarter"

(d) Absence of Blocks

There are a number of blocks which go against promoting creativity and innovation in an organization. There are to be removed Some of these are listed below:

- conceptual block: Preponderance on short-term objectives eclipse long term needs. The conceptual skill of top management is tested here.
- Organisational block: Autocratic leadership. Rigid and centralized organization structure, etc. go against innovation.
- Physical block: Bureaucratic management style. Secretiveness. Lack of free flow of two-way communication. Fear and apathy between superior and subordinate. Etc. come under this category.
- Socio-cultural block: Creativity and independent thinking of people are greatly influenced by the value system of the society. This in turn is influenced by:

(i) Socio-economic systems.

(ii) Political ideology and the government ın power.

(iii)Cultural heritage.

(iv)Religious teachings.

Individual block: The people who make the organization philosophy are greatly moulded and influenced by senior level people like the supervisors. Managers top level executives. Square pegs in bound holes can be great blocks for promoting innovative thinking.

- **Internal block:** Organised groups like labour union, officers associations. etc. can block anything new to be introduced in the organization. An excellent example is the resistance of the Indian Labour Union towards computerization in industry.
- **External block:** This absolute is placed by external agencies to the organization from introducing new methods and systems. Objectives from Government agencies, political parties, foreign colloaborators, etc. come under this category.

It is the duty of the management to identify these blocks and take conscious efforts to remove them.

2.5 CONDUCTING A CREATIVE SESSION

Alfred North Whitehead, the philosopher and mathematician, pointed out that in order to encourage our creative thinking certain guidelines are useful.

1. The following summarizes Whitehead's philosophy.
2. Dare not to be apparently illogical.

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3. Overcome inertia toward change, toward the unconventional
4. Realize that insight does not necessarily flow from a plan or a logical sequence
5. Remove all mental blocks and personal inhibitions. Let the imagination grow.
6. It helps to have crazy ideas; they should be encouraged and not ridiculed.
7. Remember all truly ideas seem absurd when first proposed.

This list of suggestions gives us effective guidelines to follow when conducting a creative session. Whitehead's suggestions apply, whether you are indulging in a solo creative session or a group creative session. Most of our thinking is done in solo sessions, though when circumstances are arranged we can have group creative sessions that payoff handsomely.

The creative session is a valuable tool in a value engineering study. A creative session allows the participants to express themselves freely without fear of being judged harshly or improperly. In a value engineering study, we ask each of the team members to participate during the creative session. The group-creative session may last anywhere from two to four hours. Each of the team members is asked to think beyond his normal habit solutions to come up with as many ideas as possible" of new combinations, new systems and new approaches to the problem.

The first rule in a creative session is to define the problem. Having defined the problem, the team develops as many ways as possible of solving that problem. They may come up with an entirely different approach, or they may take the basic approach that is proposed and modify and change certain parts of it. None of the ideas that are generated during a value session are discarded; they are all written down, regardless of their merit. The following basic suggestions are helpful to keep in mind when conducting a value engineering study:

1. The team members must believe that there can be improvements made to the project.
2. There is always room for improvement in the design.
3. Be receptive to new ideas
4. Eliminate the word "impossible" from your thinking.
5. Suspend judgment

6. Develop as many ideas as possible.
7. Look for association of ideas.
8. Don't be afraid to experiment.
9. Encourage all team members to participate.
10. Test your own views in the form of questions.
11. Help your team member's work through their ideas.
12. Record all your value engineering ideas.

The leader in a creative session should encourage the free flow of information from participants. It is important that he gently but firmly ensure that judgment is suspended during this session. The leader should also prompt and encourage each team member to freely participate.

2.6 CRUX OF CREATIVE THINKING

The crux of creative thinking, as applied in a value engineering study, requires that you separate the creative portion of your mind from the judgment portion of the mind, for two reasons: (1) To allow more associations of ideas; and (2) to accumulate a greater quantity of ideas.

You cannot dictate to your mind how it chooses to associate and build on other ideas. Our train of thought usually follows any path of association that it chooses. An example of the association of ideas may be found in the following example:

During World War II, a destroyer was halted because it had encountered a 500-pound mine that had appeared near the bow of the ship. Normal procedure would have been to destroy the mine with a machine gun. However, the ship was too close and needed to back up to avoid the mine. The caption noticed that there was another mine that had drifted across the stern. Clearly, it was impossible to blow up either of the mines without damaging the ship. One of the chief petty officers remarked: "With all the windy guys that we have on this ship, we should get them up here and blow the mine away." This remark caused someone to think: "Maybe we could use a high-pressure air hose." That thought promptly brought up another idea, and that was to use a water hose. The water hose was turned on the mine and it moved away from the ship. The first mine was destroyed and the ship moved out in turn to detonate the second mine. The association of ideas went from the silly idea of the windy guys to the better idea of the air hose, and then to a still better idea of the water hose. Had the initial idea been forbidden or the entire train of thought association might never been brought to the final solution.

The second principle of gathering a quantity of ideas is especially difficult for engineers to accept. Time and again, we take the one best and most reliable solution that we have used in the past, place it in our designs and build the project. Let's compare the principle of a quantity of ideas with the experience of the professional pearl diver. If you were a pearl diver, would you walk to the edge of the beach, climb in your boat, row to the oyster bed, put on your diving gear, swim to the bottom, find one oyster, then swim up to the top of the water, climb into the boat, then take off your diving gear and open that oyster, to find that there is no pearl? Would you then repeat the process, going down to the bottom of the ocean again to find one oyster and bring that up to the boat, to find that it, too, had no pearl? We can see that the physical action taken is a very clumsy process. However, people will follow the same clumsy mental processes without realizing it. If you were a professional pearl diver, you would put on your swim gear, dive to the bottom of the ocean, fill up the entire basket with oysters, then swim back up to the surface of the water, get in your boat and open all of the oysters until you found a pearl. When you are holding your creative session, you are looking for ideas, just like the pearl diver looks for oysters, in quantity and you will delay opening them looking for pearls until you have a quantity of them. People often follow mental procedures that are clumsy because mental processes are abstract and thus more difficult to detect clumsiness.

The objective is to accumulate a large number of ideas. Do not start looking at those ideas, or judging them, in selecting the potentially best ideas for development until you have collected a large number of ideas. This is a far more efficient approach toward unearthing and selecting creative ideas for development.

Why do we push hard on this subject of separating the creative portion of mind from the judgment portion of the mind? Because it is very difficult for cautious professional engineers and architects to do so. Their training tends to make them very conservative and to squelch far-out speculation in favor of conservative habit solutions. Creativity is not a result of training. It has to be released from within people by creating the circumstances and climate that release it!

2.7 THE CREATIVE PROCESS

Many inventors have been interviewed about the thought processes that result in their inventions. Some of the points in their responses are often the

same. The first step in tackling any problem is to first define that problem. The second step is to gather information and background on the problem, and to educate ourselves as best we can as to how the problem might be approached. One needs to become familiar with the project, without worrying about what the final solution might be. It helps also to define the requirements and what is actually needed in the design. The step in the process is to develop creative ideas about ways of providing the function of the project. The ideas are then sifted through to find the ones that have the dust potential for development and eventual implementation. There may be 20 or 30 ideas brought up for the solution to a problem. The final stage is the development and creation of the solution to a problem.

When you are working on a problem, work hard during the working day. When the workday is concluded, forget the work and turn to something that relaxes you. The reason: You can go only so far with your conscious mind. Then, by stopping conscious work, you free your subconscious from conscious limitations. Relieving the mind of anxiety permits the subconscious to incubate the problem until a new combination may be formed.

Recreation is derived from the world meaning "re-create." Let's not overlook the benefit of leisure and relaxation in the creative process. Many great discoveries have been made when the inventor's attention was directed to other unrelated areas.

When the idea materializes, be sure to write it down. Chances are great that your idea may be forgotten if it is not written down and captured on paper when it occurs.

2.8 CREATIVE PROBLEM-SOLVING TECHNIQUES

There are several creative problem-solving techniques that can be used when leading a value engineering session:

Brainstorming

In brainstorming, a group of individuals, representing different disciplines in a construction project are brought together in a group. Usually, the group is led by one-individual, and a recorder picks up all the ideas that are generated by the group session. The team participating in the study must have reviewed the background information for the project and have become familiar with the requirements of the owner. Prior to the session, the individuals in the study are briefed on the design project and on the requirements and limitations that are imposed.

Normally, no one likes inspection by an external agency on his work or design. In VE, insiders analyse their own design. Brainstorming is one such exercise. The term brainstorming refers to a group activity which produces an abundance of ideas. These ideas are subsequently refined to eliminate suggestions which are considered impracticable. This group consists of representatives from sales, purchase, R&D and production. Sitting together they examine the product being considered and formulate ideas on improving value (= Quality/Cost). This is obtained either by increasing quality for the given cost or reducing cost for given quality or by both. The steps involved are:

- Listing down all suggestions and ideas including trivial ones.
- Review the list and shortlist the ideas/suggestions.
- Subject those short-listed items for critical examination.
- Formulate the most appropriate ideas for selection.
- Conduct value analysis on most appropriate ideas and rank them.
- Recommend the ideas for selection in the form of VM Change Proposals (VMCP), This is a short written report for management for their consideration and approval.

The rules for brainstorming that were previously stated are reviewed with the team participants. A creative brainstorming session may start with an example of a project or a problem that requires creative thought. The practice brainstorming session is started by having each individual first list his creative ideas for the problem. After that is done, the team is asked to come together as a whole and work as a group in determining creative solutions to the problem. By using an example, the team quickly catches onto the concept of the free flow of thinking. The creative session provides an environment for open thought. It is an ideal situation for being yourself and being yourself and being able to express yourself clearly without fear of retribution: Psychological safety and freedom must be a part of the creative session. External evaluation by team members must be completely absent.

Many questions are critically examined at brain storming sessions. There is no standard set of questions nor is there any hard and fast rule on what to ask and what not to. The basic concept is non-conformism. However, some leading organizations have structured their questionnaires. For example, General Electric Company of the USA has devised "Ten Tests for Value", These are given below for guidance.

1. Does it use contribute value?
2. Is its cost proportionate to its usefulness?
3. Does it need all its features?
4. Is there anything better for the intended use?
5. Can a usable part be made by a lower cost method?
6. Can a standard product be found which will be usable?
7. Is it made on proper tooling considering qualities required?
8. Do the material cost, reasonable labour cost, overhead and profit total its cost?
9. Will another dependable supplier provide it for lesser cost?
10. Is anyone buying it for lesser cost?

Gordon Technique

This technique is also a group-creative technique. In many ways it is the direct opposite of the brainstorming technique. The group meets without any prior knowledge of the problem or project being studied. The leader of the session guides the term into broad areas in which the problem might be identified. As an example, the problem is to design a wastewater treatment plant to treat sewage. The discussion might center on purification. The leader leads the discussion through the consideration of the purification process and into ways that the process takes place. He might first, for instance, discuss the natural means of purification that are available in nature. Evaluation of the solutions is encouraged. The exact solution of the problem is not identified until the leader feels the all possible solutions have been explored.

Checklists

Past history and precedents on prior studies may have resulted in an accumulation of ideas that resulted in savings to the owner. This list of ideas serves as a basis for comparison on new studies. We have found it helpful to check back on past. Projects to see if there are any ideas that continuously occur.

Morphological Analysis

Morphological analysis is a systematic ranking of alternatives. The first step is to define the problem in terms of its parameters. Next, a model is developed that lists all the potential combinations that might be used in deriving a solution to the project. This often employs a system analysis to come up with the best solution. One axis of the analysis shows unit processes. The

vertical axis represents the parameter used for design, and the third axis represents the type of equipment that could be used for the solution. There are many possibilities and combinations of solutions that are available in this analysis.

Attribute Listing

Attribute listing uses the parts approach. It lists the various elements of the project, and changes are modified in each of the characteristics. This technique allows new combinations of characteristics or attributes to solve the problem.

A coordinator for a value engineering study must evaluate the project itself, as well as the composition of the team members, to determine the best technique to use in his creative session. With any of these techniques, however, these basic guidelines may be followed.

Express ideas free of criticism by suspending judgment until you reach the judgment phase of the job plan.

1. Assume that each idea will work.
2. Research ideas without restriction.
3. Capitalize from cross-fertilization of ideas.
4. Participate in a competitive spirit.

These simple rules will enhance the results of your creative session.

> ***Check Your Progress***
>
> 3. List a few creative individuals.
> 4. List two free association techniques.
> 5. List three laws of creative thinking given by Aristotle.

2.9 SUMMARY

Creative thinking is often associated with the development of a new thought or idea or concept that has not been thought of before. Creative techniques are used to bring about improvements and progress. Creative thinking may be seen as a means of overcoming problems that confront us. The prime thesis behind creativity is that the individual must believe that it can be done.

The creative thought process is composed of three main categories: imagination, inspiration and illumination. The steps in the creative process are orientation, preparation, analysis, ideation, incubation, synthesis and verification. There are a number of creativity techniques available for problem solving situations. Creativity techniques fall into three categories, namely: Free Association Techniques, Organized Techniques and Forced Relationship Techniques. For people who are creative thinkers, traditional thinking can be one of our worst enemies. It freezes our minds. It blocks our creative thoughts and prevents us from developing further.

All human development, no matter what form it takes, must be outside the rules; otherwise, we would never have anything new. There are mental attitudes or influences which serve to retard or block the creative process. This block may be categorized as habitual, perceptual, and emotional.

Top management must be committed to this concept and take initiative to create and promote suitable organization culture and working environment which promotes innovation.

Good leaders, in short, believe 'resourcefulness' is more important than 'resources'.

Organization climate should provide an informal and flexible organization structure; focus on contents and production rather than on form and procedures, open mindedness and non-conservatism and adequate two-way communication.

2.10 ANSWERS TO CHECK YOUR PROGRESS

1. Define creative thinking.

   Creative thinking is that it is a product of the imagination where a new combination of thoughts and things are brought together.

2. List the steps in the creative process.

   Orientation: Defining the problem to be solved and selecting the approach that should be taken to solve it.

   Preparation: Information-gathering and fact-finding.

   Analysis: Evaluation and analysis of the data gathered.

   Ideation: Production of alternative solutions to the problems.

   Incubation: Sorting and combining the information (slowing the pace to invite illumination).

   Synthesis: Bringing all the ideas together into a complete whole.

   Verification: Evaluation of the proposed solution or resultant ideas.

3. List a few creative individuals.

   Creative individuals are small children, scientists, pioneers, writers, housewives, architects and engineers.

4. List two Free Association Techniques.

   (a) Brainstorming

   (b) Gordon techniques

5. List three laws of creative thinking given by Aristotle.

   (1) Similarity –or like ideas

   (2) Contiguity –or adjoining ideas

   (3) Contrast –or opposite ideas

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FUNCTION ANALYSIS

3.1 INTRODUCTION TO FUNCTION ANALYSIS

The functional approach is a unique characteristic of value engineering. Deriving a concise description of the function to be performed is an essential step. Without ascertaining this, it would be next to impossible to assess the alternatives that can reduce cost.

According to Miles, the basic purpose of any expenditure whether it be for materials, or the work of people or a procedure is to accomplish a function.

As noted previously, the VE(Value engineering) discipline deals with the functions of items. Function is used here to mean the purpose or use of a product. The (Value engineering)VE approach first concerns itself with what the item is supposed to do-only afterwards it deals with the item itself. For example, before considering a fabrication method improvement for a certain part, the actual need for the function should be satisfied, and then other ways of performing the item's function are investigated. The consideration of function is the fundamental skeletal structure of the VE method, for all applications.

Value engineering is based on functional approach. A product is analysed by the function it is required to perform. Product is essentially the result of an appropriate design to perform certain primary functions. Product also has certain

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secondary functions. Logically, as per the value engineering concept, the cost/ value of the product must be distributed between these two functions, proportional to their relative importance. In other words, weightings are assigned between these functions. These will be discussed under the topic Value Analysis.

When a pen is bought, writing is the expected function. When an electric cable is bought, it is expected to conduct current. The following questions will lead to the conclusion of the functions performed by a product.

What is the purpose of the product?

What does it do?

What does it cost?

What does it worth?

What alternative can do the function?

What would the alternative cost?

These functions may be classified into basic or primary functions and secondary functions. The basic function refers to the core job the product is supposed to do. Secondary functions are the support functions that may be needed but do not perform the basic job.

Primary Function

Primary functions are the basic purpose of the product and/or the service. For example, consider the case of a personal stereo system(walkman). The primary function of the walkman is to reproduce recorded music. Considering the fashion among students to carry a walkman around, perhaps one could even say the primary function is to provide 'status symbol'. The important thing is that within the organization there should be an array of views with regard to the desirable functions. One of the basic objectives of a manufacturing organization is to make profit. While the primary functions are decided, the organization must not forget about its competitors. The product must compete with similar products in the market and look more attractive to customers. If the primary function of a walkman is 'reproduction of music', one may not go in for the external look of the product: It 'status symbol' is also one of the primary functions, additional features will have to be made to ensure that the set has a 'modern look' to attract customers such as an excellent finish with attractive colours and/or providing 'graphic equalizers and optional features like stereo effect etc.,

Secondary Functions

This is derived from design considerations. If the design is based on the wiring of transistors and valves, such items provide the secondary functions. If the design is based on ICs and PCBs, the method chosen to perform the basic function changes and secondary functions are provided not by transistors and electronic values but by ICs and PCBs.

This classification can be clearly understood with the help of an example. The basic function of a pedestal fan is to create air circulation. The table describes some of its parts and their functions.

Parts	Function	Basic	Secondary
Base wheels	Support load	Transfer load	Enhance mobility
Base	Supports load	Spreads load	
Pedestal	Supports arm	Raises the fixture	
Regulator	Adjusts speed	Switches Off/On	
Wire and Plug	Connects the power supply	Conducts the power	Provides insulation
Metal shield	Prevents Contact with wings		
Extension arm	Supports the fixture	Conceals the wire	
Rotation Controller	Regulates the direction of air flow		
Motor	Rotates the wings		
Wings	Produces air flow		
Paint	Prevents rusting	Adds aesthetics	
Screws Nuts & Bolt	Keeps different Parts together		

The pedestal fan helps in understanding the relationship between basic and supportive functions. When looking at the system as a whole, the basic function is to create airflow. And the parts which accomplish this function are the motor and the wings only. All the other parts are only serving supportive functions.

These components or parts are then individually subjected to value engineering study. Then each of them has a basic function as well as supportive

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function. For example, the basic function of paint is to prevent the various parts of the pedestal fan from rusting. But it also adds to the aesthetic appeal of the fan.

Similarly in a waste water treatment plant, the building exterior walls were constructed of cast – in – place, concrete – bearing walls with precast concrete double T's for roofing planks. A comparison was made on the cost of job-cost roof beams for the structural support system for the building. Insulation properties for both wall systems were similar. The designer – engineering further evaluated the roofing system and its final design utilized a steel foist and metal – pan deck system for the roof. Cast – in – place exterior walls were modified slightly to complete the final design.

Comparisons are a normal step in the architect / engineering's procedure for doing a design. After completion of a function analysis the value engineering team has a clearer picture of the purpose of the project and the related cost for performing that purpose clear insight into the high cost are do of the project help the reviewer to concentrator his efforts where the largest expenditures are being mode.

Optional Functions

In addition to the primary and secondary functions, there may be some other functions which are not directly related to these two functions. These are termed 'optional functions'. Some of these may be found unnecessary during value analysis.

These are functions which do not directly contribute to its functional value. Providing additional circuitry to make the walkman operate on voltage mains or have facilities like graphic equalizers and stereo-effects are examples of optional functions. In addition to providing battery cells, a battery eliminator circuitry can also be provided. Obviously, optional features cost money but the resultant value is only marginal. If it is not properly applied, the high cost might make the product non-competitive. A value engineer must eliminate unnecessary functions. If a function can be eliminated, then the need to find out the means of reducing the corresponding component's cost for retaining such function can also be done away with. The best option is to eliminate the same all together. This will make the product more competitive and yield better profits. This aspect is illustrated with an example given here.

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Illustration

Consider a dot-pen. The primary function is 'to write'. Table shows the main components and distribution of the various functions between them.

Sl. No	Item	Function	Primary	Secondary
1.	Dot Point	To write on paper.	Yes	-
2.	Plastic body	Facilitates holding in between fingers.		Yes
3.	Top cover	Prevents dust and acts as holding filler.	-	Yes
4.	Bottom guide	Guides filler and fits the outer body and inner filler together by grooves.	-	Yes

3.2 ADVANTAGES OF FUNCTION ANALYSIS APPROACH

The function analysis approach has several advantages which have made it the focal point of value engineering. Listing of a few of those advantages which we have recognized is not always easy; however, after we have bounced our ideas around and have communicated what each team member feels that function should be, we will have a better grasp of what the projects is about. The advantage of the two-word definition is that it helps as communicate the ideas better to ourselves, and as a result we can communicate them to someone else with little ambiguity them to someone else with little ambiguity. It is a very powerful tool to make you think in greater depth about what you are doing. The exercise of the function analysis helps us to evaluate functions with a greater depth of thinking.

Don't be surprised if when performing a function analysis of a project you find something that is not performing a function and that can be totally eliminated. Why is it there? Why is it there? The answer might be: "Well, we always put it in these types of designs; it's been in our designs for the past 20 years." In the days when horse-drawn artillery was used in wartime, one man made a statement that the horses didn't get away while the artillery was being fired. In addition, they were the individuals who loaded and fired the cannon.

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After this process became mechanized, all these problems simply disappeared. The advantages of function analysis approach are as follow:

1. It forces conciseness and eliminates fog.
2. It identifies what the buyer wants in the form of function, not things.
3. It distinguishes between the parts and the functional approach.
4. It forces us to think in great depth and
5. It helps us to communicate what we are actually doing into a more enthusiastic give or take discussion of cost versus worth.

Larry Miles, in his book titled Techniques of value Analysis and engineering, states that "the large and more compiled the object undergoing analysis, the greater the number of comparisons necessary to make the analysis sufficiently comprehensive to establish the best value for each included function. This means analyzing a series of basic functions, each discovered by breaking the assembly down into its subsystems, components, and parts In a way, the problem becomes perhaps one of comparing the use of one material with that of another; the style of one part with that of an equivalent; the application of one process of manufacture with that of another, etc."

Typical Function Questions

1. What does it do?
2. What is its projected use?
3. What is the design speed?
4. Who will use it?
5. How will it be used?
6. What is the location?
7. Are major cut and fill volumes required?
8. Is a cut to be made in rock strata?
9. Do soils have good compaction characteristics?
10. Are right-of-way costs reasonable?
11. What type of bridge structures are needed?
12. Are standard specifications out dated?
13. Is steel or concrete more economical for bridge construction?
14. Are energy efficient (gas consumption) grades used?
15. Can planting save maintenance costs?

16. Are standard specifications for planting applicable to the entire state? Example: Florida may have several different growing zones. What will grow in one location, will not function in another
17. What grade of steel is used?
18. Do flood levels and impact loads from river traffic affect bridge design?
19. Are pavement sections economical?
20. Are piles needed?
21. Is alignment optimized?
22. What is spent on signage structures? Can they be mounted on overpasses?
23. Can temporary barriers be used in the completed projects?
24. Can natural noise barriers be utilized?
25. Will high mast lighting save money?
26. Is it cost effective to make provisions for future expansions (bridge widths, drainage structures, etc)?

In a contraction project, a comparison of the total system would be made, and then a comparison of each of the component parts.

Comparisons of the cost of the function that are being performed and their related cost must be made suppose. For instance, you are evaluating three bolts for an engine mount. Bolt A costs Rs.50, Bolt B costs Rs.5.00, and Bolt C costs Re. 1.00 Assume that all three bolts provided the required strength as outlined in the specifications and proven by testing. Which bolt would you buy? The Rs.1.00 bolt provides the required performance functions at the least cost. Yet very often people try to persuade us to pay exorbitant amount.

Discovered that there were still three men on an artillery crew. Further analysis showed that the third man really didn't have a function. When they traced back the origin of the make up of the artillery squad, they found that this tradition of staffing an artillery crew had followed through into the era of mechanized artillery. Things like this often happen.

3.3 FUNCTIONAL ANALYSIS SYSTEMS TECHNIQUE (FAST)

It is a systematic road mapping of functions. Complicated process or assemblies and determinates is a step-by-step method. The function required

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Check Your Progress

1. What are the primary functions?
2. What are the secondary functions?

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and a means to arrive at that function. FAST diagrams are applied to any series of functions that relate to each other. Diagramming each action or step required for the mechanism to function. In the construction industry, FAST is used to determine, project function as well as the function of each part of the project. FAST is best applied to clarity and to simplify an object or procedure into identifiable parts. The graphic presentation of function is the FAST diagram.

The originator of FAST was Charles W. By the way, value Engineering and cost Reduction Administrator for UNIVAC of salt Lack City, Utah. By the way first introduced his technique in a paper delivered to the Society of American Value Engineers at the 1965 National Meeting in Boston. This was the first major expansion of the functional approach originated by Lawrence D. Miles.

FAST has developed into an effective tool for evaluating existing procedures, structures, components, machines or other objects. It also serves as a problem solving technique by identifying the required functions to be performed and the other supporting functions. The final result is a proposed solution to the problem consisting of the steps required to achieve the function.

FAST is a visual representation of functions and identifies the areas of greatest impact of these functions on costs. It is an inter-action between function and cost.

FAST is like a network diagram.

The following steps arc followed for construction of FAST

(1) Use verb and noun for describing functions

(2) These functions are written on small cards.

(3) First select the Basic Function card. Arrange other cards by answering the following questions.

(1) How is this function performed?

(2) Why is it performed?

(3) When is it performed'?

The logical sequence of functions (basic and secondary) generate a critical function path.

It consists of only critical functions. FAST is bounced on both ends by scope lines.

The application of FAST may be as a problem-solving tool for existing objects, problems or procedures, or as a means to develop solutions knowing

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only the desired function. The purpose of FAST is to simplify the design, operation, plan, procedure or problem into identifiable functional parts there by simplifying the problem. Each subsequent function is evaluated as to its effectiveness or usefulness with the hope of eliminating, modifying, or reducing functions. All functions are identifiable as two work verb noun descriptions. Examples of FAST may be found in several application areas. In the design of a water treatment plant, FAST can be applied to develop alternative unit processes required to satisfy the basic function of purify water. In industrial plants FAST is applied to the manufacturing process by identifying each in the assembly procedure. It can be used to evaluate existing processes or to arrive at new process approaches. Companies facing dwindling profits may apply FAST assuming the basic function is to increase profits and finding the required functions needed to make a profit.

The value of every product is a function of its utility and cost.

$V = U/C$ where

V = Value, U=Utility, C=Cost.

For constant utility of an item the value varies inversely as the cost.

This is called the value ration. For a value Engineered product, the ratio should be more than unity.

The first step for the implementation of a value Engineering programme is the selection of products to be analysed. Value Engineering makes its mark during the maturity stage of the product. This means that one has to start thinking along these lines during the later part of the growth stage. What is important is the switch over from performance oriented thinking to value oriented thinking. The two approaches for the choice of products for Value Engineering are through ABC analysis and contribution analysis. In the ABC analysis, the products are classified according to sales or consumption value and ranking in descending order. The products which offer the maximum sales or consumption value are selected. These would offer the best result in terms of returns when analysed.

The basic framework for value engineering approach is formed by the following questions.

1. What is the item?
2. What does it do?
3. What does it cost?
4. What else would do the job?

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5. What would be alternative cost be?

Value Engineering requires these five questions to be answered to be answered for the successful implementation of the Technique. The basic steps are identifying the function, evaluation of the function by comparison and developing alternatives.

There are various approaches like.

a) Syndicate Approach b) Buzz/Sessions c) Brain Storming d) DARSIRI Method

DARSIRI is the most common and effective technique adopted in Value Engineering. This is the most scientific method adopted. It consists of Data collection, Analysis, Recording ideas, Speculation, Investigation, Recommendation and Implementation.

In this "Analysis" is the most important stage. It should be related to the function or utility to be achieved. The most desirable methodology for cost reduction is the code of 10 Tests" formulated by Lawrence D. Miles, the father of Value Engineering.

They are:

1. Does function contribute value?
2. Is the cost proportionate to its utility?
3. Does it need all its features?
4. Is there anything else, better to serve the intended purpose?
5. Can a usable part be made by lower cost method?
6. Can a standard product be used?
7. Considering the qualities used, has it been made on proper tooling?
8. Do materials, reasonable labour, overheads, and profit total its cost?
9. Will another supplier provide it for less?
10. Is anyone buying it for less?

Value analysis problems can be solved by certain simple considerations.

Can we eliminate the item altogether?

Should we eliminate the item altogether

Should we modify or change the item to another item with better value?

The Answers to the code of 10 Tests should broadly fall within the four categories constituting what is called "a qualitative rating scale: These categories are

A. Indispensable

B. Needed with improvement

C. Needed in alternate form

D. Unnecessary

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The answer 'Yes' or 'No' may apply where rating is not possible. Sometimes "Yes or No" may accompany the ratings. The areas for which the answers are in "A" and "D" categories do not require analysis. Areas to be concentrated upon are those coming under categories "B" and "C"

And organization whether large or small can benefit from Value Engineering. Large organizations can easily organize a Value Engineering section with the continuous support of the Top management. Value Engineering builds spirit-de core.

Constructing a FAST Diagram

Start by drawing a scope line to the left side of the paper and placing the basic function immediately to the right of the scope line. This is the higher order scope line. By asking why and. How questions about the functions will result in other sequential or support functions. The answer to the why question should be placed to the block to the left of the function and to the how question to the light of the function. For existing items index cards are often used to write down all the known functions and then arrange them in sequential order to occurrence. Functions which are shown Horizontally Across the Diagram Horizontally arranged functions, positioned as described above for the answers to the why and how questions, must also meet a sequential order of events requirements i.e., the earlier time functions appear in relative time sequence, starting at the right side of the FAST diagram. As a function occurs later in the sequence, it will be found progressively further to the left in the why direction. Any function which does not meet this time sequence relationship is either located incorrectly in the horizontal chain of functions, or perhaps should be considered as a concurrent function and placed vertically below the function about which the why and how question has been asked. As an example, the question how to remove pollutants may be answered by several concurrent functions, depending on the different types of pollutants. Functions which have sequential relationships are arranged horizontally. Understanding of the problem will result by asking these questions. Applying these questions to a function will result in a sequential higher or lower order function. The mapping of these functions is the FAST diagram. Higher order functions are usually the

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requirements defined by the user, while lower order functions are generally the solutions to the problems in accordance with the answers to why/How logic questions, as follows:

The how question: The answer should lie to the immediate right of the function about which the question was asked. If the function to the immediate right does not provide a logical answer to the how question, then the how answer function has either been described improperly or is in the wrong place. The how question should be phrased- "How do I (verb) (noun)?"

The why question: The answer line to the immediate left of the function about which the why question was asked. If the function to the immediate left does not provide a logical answer to the why question, then the why answer function has either been described improperly or is in the wrong place. The why question should be phrased- "why do I (verb) (noun)?"

Function which are shown vertically in the diagram are those functions having a time sequence relationship. Functions which do not have a time sequence relationship, should be shown in a horizontal line. These are functions which occur either at the same time or all the time and are called concurrent supporting functions. These functions can be required secondary functions, aesthetic functions, or uncounted functions. It the function happens at the same time and explains or elaborates on some function in the horizontal chain of functions, it should be placed below the horizontal path function.

3.3.1 Functional Analysis system technique: Strategic planning

Function analysis is an important aspect in value analysis. In the first instance, various functions are listed down against each product and each of its sub-systems and major components. Having listed down these functions, the next step is to rank them in order of their importance. Various management techniques are available to lay down their relative weightings. Some of these are described here.

(i) Graphic rating scale: Depending on the relative importance, the functions can be ranked in a rating scale. These could be 5-point scales, 7-point rating scales, etc. Weightings are assigned to each scale as illustrated on a 5-point scale below.

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Rank	Scale	Point
1	Very high	5
2	High	4
3	Medium	3
4	Low	2
5	Very low	1

Having listed down the functions as per a rating scale, these are ranked as per the weightings. Consider the example of a dot pen. Let us examine the various functions of the 'top cover' used in a dot pen. These are given in the following table.

Function Analysis	
Symbol	Description
A	Prevents dust from entering
B	Facilitates clamping on shirt pocket
C	Holding the filler
D	Pleases customers by it appearance

As per a 4-point graphic rating scale these can be ranked as follows

Function	Rating Scale	Points	Relative weightings	Ranking
A	Very high	5	*0.36	I
C	High	4	0.29	II
D	Medium	3	0.21	III
B	Low	2	0.14	IV
	Total	14	1.00	

*5/14=0.36

Hence, the sequence of importance is ACDB

(ii) Point method under this method relative importance is given to each function by assigning points. Points are assigned by value engineers, depending on the difference between the importance of two functions, when compared with another, as per the following norms:

Difference	Points
Minor Difference	1
Medium Difference	2
Major Difference	3

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Let us apply this to the above problem of top cover of the dot pen. Here functions are compared to one another and points are assigned at the respective square in the following Table

	A	B	C	D	Total	weightings
A	0	2	1	3	6	0.46
B		0	3	1	4	0.31
C			0	3	3	0.23
D				0	0	0.00
					13	1.00

When comparing functions A and B, the difference is medium and the point assigned is 2. Similarly between A and C, the difference is minor and the point assigned is 1. Between A and D, there is a major difference and hence 3 points are assigned. Applying similar logic to B, we get points 3 and 1 under columns C and D respectively. When C is compared with D, the difference is major and hence 3 points are assigned. The final ranking is given in the following Table.

Symbol	Functions	Rank
A	Prevent dust	I
B	Clamping	II
C	Holding filler	III
D	Pleasing	IV

Hence, the sequence of importance is ABCD

(ii) Forced Matrix Method: Calculation of attribute weightings coefficient (AWC). In this method only two functions are compared at one time. Points 1 and 0 are assigned depending on which is more important and less important respectively. In the above example of the top cover of a dot pen, the matrix table is developed as follows in the following table.

Function	A	B	C	D	Total	weightings	Rank
A		1	1	1	3	*0.5	I
B	0		0	1	1	0.17	II
C	0	1		1	2	0.33	III
D	0	0	0		0	0.00	V
Total	0	2	1	3	6	1.00	

Compare A with C, C and D and assign '0' and '1' as we proceed. Later, compare B with C and D. Lastly, compare C with D. If there are 'n'

functions and the number of comparison is (c), Attribute Weighting Coefficients (AWC) is given by the following:

$$C = \frac{n(n-1)}{2}$$

$$AWC = \frac{S^{n}_{T=1} W_{L}}{c}$$

In the above example, the number of comparisons = 4 x 3/2 = 6. This procedure in assigning '0' and '1' is explained here.

Take function A. Compare A with B. Obviously 'preventing dust' is more important compared to 'clamping'. Therefore, A is given point '1' and B, point '0'. Hence '1' is entered against row of A under the column B. Similarly. '0' is entered against the row of B under column A. In the next step A is compared with C. A gets 1 and C gets 0. These are entered against rows representing A and C under the columns of C and A respectively. Lastly A is compared with D and 1 and 0 are entered against row A and row D under columns d and A respectively. Repeat for B, C and D, similarly. These are shown in the above table. The ranking order is ACBD.

(iv) Comparison of the above three methods It has been found that the graphic rating method and forced matrix method have yielded similar results in ranking functions, viz. ACBD, whereas, the point method yielded a different sequence, viz. ABCD. Both the graphic rating and point method have the limitation of not being objective. This is because the points assigned in both cases are based on the discretion of the value engineer and is hence subjective.

Functions	Ranking		
	As Per Rating Scale	As Per Point Method	As Per Forced Matrix
A	1	1	1
B	2	2	3
C	3	3	2
D	4	4	4

The forced matrix method is superior to the other two methods because it is more objective. This is so because only two functions are considered at one instance. The comparison is not rated in points or marks which are subjective. Hence comparison is made as 'more important' and 'less important' marking them 1 and 0 respectively. When only two are considered at one time comparison becomes more easy. This method is also reliable.

Techniques of Examination

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Some of these are listed as follows.

(i) Forced comparison: Suppose we are examining a cast used in an equipment for the purpose of reducing its cost. Cast is after all a container. In order to compare the features of the subject item, we may pick up any other container or even a cast made out of different materials as our object for simulation.

(ii) Attribute listing: In this method the attributes are listed in a matrix form to give a better appreciation of its functions and performance. For example, let us consider technical equipment having a number of sub-systems.

Attributes	Sub-systems		
	No. 1	No. 2	No. 3
Heat Resistant	Yes	No	Yes
Corrosion-Resistant	No	Yes	Yes
Maximum Speed in rpm	2000	3000	5000
MTBF in Hours	2000	3000	4000

In another variation, the desirable attributes are listed in rows and columns where the intersections represent combinations to give better appreciation, more ideas and alternatives.

(iii) Morphological Analysis: This is similar to attribute listing but has different parameters, which are independent of each other. Let us consider a simple example of the design of a table lamp which has the following parameters.

Item	Symbol
Material	X
Lighting	Y
Aesthetics	Z

Under each of these parameters, we have different attributes as follows:

Material: Metal (A), Plastic (B), or Wooden (C)

Lighting: Direct (D), Indirect (E), or Diffuse (F)

Aesthetics: Colour (G), Finish (H), or Shape (I)

A diagrammatic representation of the three attributes is shown below. This gives a number of choices.

Various combinations are thus possible for designing the table lamp.

(iv)Parametric analysis: There are the number of complex equipment having many sub-systems and whose design calls for analysis of a number of parameters. This is based on a concept different from that of morphological analysis. For example, in this analysis various parameters are grouped under different headings such as:

(a) Technical parameters

(b) Environmental parameters, etc.

Weightings are assigned to each group. Each parameter is then analyzed. Each parameter has various attributes. Based on the same, weightings are assigned to such parameters within their groups. These are called Attribute weighting Coefficient (AWC). In order to understand the product clearly and to find their intra-relationships with one another, these are listed in a matrix form. One such table is given below. This is a multidimensional matrix. Based on weighting coefficients, alternatives are ranked. The following symbols are used.

Symbols:

EWC = Environmental weighting Coefficient

PWC = Parametric weighting Coefficient

AWC = Attribute weighting Coefficient

Parametric Analysis

	Name of the Product/Process:					
Technical Parameters	Environmental Parameters					
	Endogenous EWC =		Quasi-endogenous EWC =		Exogenous EWC =	
	PWC	Attributes	AWC	Attributes	AWC	Attributes
Technology						
Production						
Operational						
Quality						
Maintenance						

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(v) System-analysis approach:

The problem can be analysis based on the system analysis approach. The salient features of this approach are:

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- The whole system consists of a number of sub-systems
- Operation is possible by the integration of all systems for the common objective
- There is input, processor and output
- The deviations are corrected through controlled mechanism initiated by feedback
- Output depends on objective constraints and criteria of measurement

(vi) Brain storming:

In this technique a group of informed people who are aware of the problem are encouraged to put up their suggestions and ideas to solve the same. Environment for brainstorming session is arranged in such a way that it encourages free flow of ideas without fear or favour.

(vii) Analytical approach:

Here the problem is analysed through experiments, simulation and through mathematical modeling until the complex system is reduced to a number of simple problems. These simple problems are further analysed giving rise to a set of simple solutions. Analytical method is the method of converting complex and unfamiliar problems to simple and familiar ones with a view to find solutions through logical applications of scientific knowledge and mathematical methods.

(viii) Synthetic approach:

This process is carried out in two steps, viz.

Complex to simple: This is the analytical method discussed above. (b) Simple to complex: In this approach, an apparently simple problem is made complex by transformation, transposition, and/or inversion and other techniques. This approach is found very essential to understand the problem threadbare enabling development of lasting solutions by application of modern scientific and technical knowledge. An analogy can be drawn to the familiar method of using transfer function (TF) in control engineering where the problem is transformed from a real plane to an imaginary plane (z plans) and its roots located. Synthetic research has identified four mechanisms. These are:

- **Personal WI analogy:** This is the method of personal identification with the problem by putting one's own self into the situation to experience the various aspects of the mechanism.

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- **Direct WI analogy:** Here the given mechanism is compared with similar equipment, technology, facts or knowledge in order to obtain either full or partial solution based on similar analogy.
- **Fantasy WI analogy:** Here man's imagination has complete freedom to explore new horizons to find unconventional solutions. This process generates entirely new. And fantastic solutions to the given problem. This is the creative spirit which gives rise to innovative ideas and solutions. This might lead to new developments and discoveries. Creativity and innovations playa vital role in value engineering. A separate write-up on creativity is added at the end of this chapter.

Development of Alternatives

After having critically examined the facts, the next step in value engineering is to develop alternative solutions to increase solutions to increase value per unit cost. Creativity and innovative spirits are best demonstrated in this phase. The steps in this phase are:

- List down all possible alternatives without passing judgment against any.
- Subject the above list for a close scrutiny to weed out undesirable and impracticable and unfeasible alternatives.
- Prepare a short list of alternatives.
- Select the best alternative.

This last step is achieved by subjecting the shortlisted alternatives to further intensive analysis using techniques which are not only objective but also give sufficient inter- weightings to functions using under consideration.

Various types of objective methods are developed. These are basically matrix-methods. Some of them are discussed here.

Functional Rating Number (FRN) Method

A case study conducted by the author is taken up as a problem here. A manufacturer of refrigerators wanted to cut down the cost. Out of various points studied it was found that the compressor accounted for nearly 60% of the cost of production. The compressor consisted of a container which was of a metal cast with certain internal mechanisms. On further examination, it was found that there was little scope to change the design of the internal mechanism. Hence the compressor cast was taken up for value analysis. As per the original

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design, the cast was made up of costly Grade 1 metal and cast out of plaster-rubber moulding process. This casting method employed was up-to-date and based on modern technology and yielded superfine finish. However the process was very costly.

Following are the various steps used in the FRN method.

Step 1: Identify Functions:

Subject the item to critical examination and list down the functions. In the case of casting, these are the following:

- Support weight and locate internal mechanism
- Provide hermetic sealing to the Freon fluid
- Easy assembly and maintenance
- Protect internal mechanism from moderate shock/impact during transportation/movement and provide support
- To withstand high temperature
- To provide heat dissipating capacity.

Step 2: Rank the above Functions:

Various methods of ranking are used. Accordingly, these are ranked as given below:

Symbols	Ranking	Functions
1	VI	Withstand high temperature
2	V	Heat dissipating capacity
3	IV	Withstand shock impacts
4	III	Easy assembly and maintenance
5	II	Provide hermetic sealing
6	I	Support weight and locate parts

Having ranked them, enter them in a matrix along a row in the ascending order.

Step 3: Assign Functional number:

In this step Functional Rating Number (FRN) is allocated. This arbitrary numbering is left to the discretion of the value engineer. It is similar to a rating scale discussed earlier. The FRN numbers can be on any scale; normally 0 to 10. Since the ranking is already decided the same order of importance is maintained in assigning FRN, giving higher number to functions having higher ranking. However, there are instances where one or two functions can be of

the same importance. In such cases, allocation of the same number to both establishes this aspect. This is one of its advantages, in our example, functions 1 and 2 are approximately of the same importance as compared to others and hence the same FRN number is allocated, namely 1.

Step 4: Develop Alternatives:

In this step various possible alternatives are developed. Innovative and creative skills are applied to find alternatives. In this case study, the authors identified the following alternatives.

Symbols	Alternatives
A	Existing design to continue
B	Dispense with compressor casting
C	Use less costly RM for casting viz., metal Grade II
D	Use less costly casting methods, viz, sand moulding
E	Use FRP containers

Step 5: Assign Satisfaction Factors (S) to Alternatives:

In this step, alternatives are compared with the desired function, and a number indicating how far the alternatives meet the function satisfactorily is indicated. Here also the numbering scale and the actual numbers are left to the discretion of the value engineer. Normally a 0-10 scale is used.

Step 6: The computation is carried out in this step wherein alternatives are given an overall rating by computing their weighting (W) using the formula:

$$W = L(FRN \times S)$$

This will enable management to pick out the most important set of alternatives.

FRN Matrix Table

Functions	1	2	3	4	5	6		
Rank	V	IV	IV	III	II	I		
FRN	1	1	3	5	6	9		
	S=Alternatives Satisfaction Factor						W	Cost
A	3	6	6	7	9	10	206	Rs.6000
B	0	0	0	0	0	0	0	0
C	3	6	8	9	9	10	222	Rs.3000
D	3	6	7	8	9	10	214	Rs.5400
E	3	6	6	1	9	8	158	Rs.40000

Analysis:

The following are evident from the above table.

1. Alternative B is discarded outright as it gives zero weighting.
2. Alternative C has maximum weighting, viz. 222, points where maximum cost reduction of Rs 3000 is envisaged (viz. 6000-3000)
3. Alternative D is also equally acceptable with the second highest score of 214 points and cost reduction of Rs. 600 (viz. 6000-5400)
4. Alternative E has lesser points compared to the present design even though the cost reduction is Rs. 2000. On examination, this alternative fails miserably to meet the function No.4 viz. 'easy assembly maintenance'. It is a common knowledge that compressors are required to be reopened and resealed during repair/reconditioning. This is not convenient with FRP materials.
5. Recommend both alternatives C and D.

Forced Decision Matrix System

The FRN method has two disadvantages, viz. it is subjective and arbitrary. Arbitrary methods are used here, in assigning the FRN numbers and satisfaction factors.

The FRN can be made more objective by following the forced decision matrix system. This method is illustrated as follows for the same problem discussed above. Following steps are involved.

Step 1: Compute Functional Attribute Weighting

Coefficient (A WC) Prepare the following table for the functions and assign '0' and '1' as indicated.

AWC Table

Functional Attribute	1	2	3	4	5	6	Total	AWC= W/c
1		0	0	0	0	0	0	0
2	1		0	0	0	0	1	0.067
3	1	1		0	0	0	2	0.133
4	1	1	1		1	0	4	0.267
5	1	1	1	0		0	3	0.200
6	1	1	1	1	1		5	0.333
Total	5	4	3	1	2	0	15	1.000

Symbols: n = No. of attributes (= functions) = 6;W = Weighting

c = No. of comparisons = n(n-1)/2 = 6 x 5/2 = 15

Symbol	Attribute	Symbol	Attribute
1	Withstand high temperature	2	Heat dissipating capacity
3	Withstand shocks	4	Easy to assemble and maintain
5	Provide hermetic sealing	6	Support weight and locate points

Step 2: Computer Alternative Sample Weighting Coefficient (SWC)

Each alternative solution is compared with the desired function in order to evaluate their relative weighting. A sample computation is given below:

a) Function 1: Withstand High Temperature. Here the question is how far the given function (in this case 'withstand high temperature') is satisfied for each of the alternatives. This can be stated either in qualitative terms like Excellent, Very good, Good, Fair or Poor. The same can also be expressed in quantitative terms on a merit scale. In a 5-point merit scale the above rating is stated in quantitative terms as follows:

Excellent = 5

Very good = 4

Good = 3

Fair = 2

Poor = 0

(i) Merit Rating Table

The merit rating table is thus drawn and given below:

Alternatives	A	B	C	D	E
Merit Rating	3	0	5	4	2

(ii) SWC Table

From the merit rating table, SWC matrix is developed.

SWC Matrix

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Functional Attribute	A	B	C	D	E	Total	AWC
A		1	0	0	1	2	0.2
B	0		0	0	0	0	0.0
C	1	1		1	1	4	0.4
D	1	1	0		1	3	0.3
E	0	1	0	0		1	0.1
Total	2	4	0	1	3	10	1.0

(b) Function 2: Heat Dissipating Capacity

(i) Merit Rating Table

Alternatives	A	B	C	D	E
Merit Rating	3	0	5	4	1

(ii) SWC Table

From the above, a corresponding matrix table for SWC is developed.

	A	B	C	D	E	Total	AWC
A		1	0	0	1	2	0.2
B	0		0	0	0	0	0.0
C	1	1		1	1	4	0.4
D	1	1	0		1	3	0.3
E	0	1	0	0		1	0.1
Total	2	4	0	1	3	10	1.0

(c) Function 3: Withstand Shock and Impacts.

(i) Merit Rating Table

Alternatives	A	B	C	D	E
Merit Rating	3	0	5	4	2

In the case study discussed above the company accepted the recommendations to select both alternatives C and D, viz.

- Use Grade II metal for casting instead of Grade 1
- Adopt sand moulding instead of plastic-rubber moulding

The saving obtained is computed as follows.

Method	Cost in Rs	Saving in Rs	Cumulative Saving in Rs.
Original design	6000	--	--
Alternative C	3000	3000	3000
Alternative D	5400	600	3600

NOTES

$$\text{Overall saving} = \frac{3600}{6000} * 100 = 60\%$$

Note:

1. Alternative C reduced the material content thereby saving on variable cost in the order of Rs. 3000 i.e., 50% of the original cost.
2. Alternative D reduces the capital cost by using chapter moulds. The reduction on the fixed cost per unit was to the order of Rs. 600, viz. 10% of the original cost.
3. Since the compressor was hidden there was no need to use plastic-rubber mould which is necessary when excellent surface finish is needed. In this case this could not add aesthetic value or sales appeal.
4. In this particular case both alternatives were feasible.
5. Something it is not be possible to select more than one alternative. In such cases go for higher ranking alternative to obtain better saving.

Installing New Design Process

Once the new design is approved it is desirable that the new design/ process is implemented under the supervision of the value engineer. In this phase the following aspects are emphasized.

- Install the new design/process as soon as possible and
- Remove impediments/obstruction if any, before the new design/ process is implemented
- Mobilise active support of persons directly involved in implementing the changes
- Demonstrate that the top management will support any new design/ method, by visible overt actions
- Work out the implementation plan with a specific time schedule. Use of PERT/CPM techniques are recommended
- Watch the new design/process after installation and obtain feedback from as many sources as possible

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- Bring about modifications/change of design based on such feedback
- Repeat the process of implementation feedback and modification till the new design is fully proved and its efficiency is adequately demonstrated

Maintain New Design/Process

The installation phase is considered completed once the new method/ design is tested with or without minor modifications and operated satisfactorily for some time. Having reached this stage, the value engineer must now ensure that the new design is frozen and protected from unauthorized changes. In addition, information in regard to the new design must reach all concerned. This requires incorporation of necessary amendments in design data, process sheet and other manufacturing documents. These are summarized below:

- Freeze the new design
- Issue amendments to the design department in the form of change notes
- Issue amendment to BOM, to the materials department
- Issue amended process sheets, and other manufacturing documents
- Inform the changes implemented along with its implications to all the concerned departments like accounts, production, planning, materials planning, etc.
- Carry out routine checks

Example:

Examples of the application of FAST diagramming are illustrated by the analysis of long range planning for a typical company. The analysis of design requirements for a prison reception and processing center is shown in figure. Portions of the text for FAST diagramming were taken from the value engineering workbook .

Accomplishment of a basic function: It may make the item "sell" better or work better because of improved appearance or convenience of use.

An Unnecessary Function is an element or a characteristic which is not necessary for the item to work or sell. Unnecessary functions are usually the result of honest wrong beliefs / assumptions, or the perpetuation of obsolete requirements that can be removed or modified.

A higher level function is a function that appears to the left of another function in a FAST diagram. The higher level function can be found by asking the question why the function must be performed.

A lower level function is a function that appears to the right of another function in a FAST diagram. The lower level function can be found by asking how the function must be performed. Critical path functions describe sequentially how or why an adjoining function is performed.

Scope line is an imaginary line drawn to the left of the basic function and to the right of the diagram to define those pieces under study. Functions to the left of the higher order scope line are higher order functions which may not be a part of the item being studied and those items to the right of the lower order scope line will likely be the solution to the project

Applying the FAST Diagram

FAST uses three basic questions to begin breaking down seemingly tough problems. What is the problem? Why is a solution necessary? How can the solution be accomplished? A better

With complex procedures for filling and paying for claims will find FAST effective in simplifying the claims procedure to identifiable functional steps. Mapping the functions will quickly reduce the complex procedure into manageable, identifiable set of lower functions that will be much easier to evaluate and subsequently modify.

To under stand the FAST technique it is first necessary to know definitions of the terms applied to the process. The diversity in definition of different types of functions substantiates the fact that FAST is a refinement and advancement in the normal functional approach.

A function is the characteristic of an item that fulfils the needs or desires of the uses; it is that which makes an item work or sell; it is purpose of an item or procedure. It is described by a verb and noun without identifying the actual part or assembly performing the function.

A Basic function is the required function purpose or procedure that the item under study is required to perform. The purpose or performance feature which must be attained. It represent the primary objects of the items, whether it be hardware, software, procedures, methods or physical objects.

A supporting function is the characteristic of an item which is not essential to the user. Although often desired it does not contribute directly to the main function.

3.3.2 Function Analysis of a Waste Water Treatment Plant:

Function analysis of a waste water treatment plant can be carried out by subjecting the total system and the various parts of the system to the following considerations.

NOTES

Total System

1. What does it do?
2. How long does it need to be?
3. What degree of treatment is needed?
4. How does it work?
5. What does it costs?
6. Are there any pollutants that materially increase the cost of treatment?
7. What is the cost per gallon of liquid treatment? For solids handling?
8. What are the percentage of costs for site work, liquid treatment, solids handling and administrative services?
9. What is the cost associated with the type of pollutant treated?
10. Does the site require extensive conveyances and transportation to deliver the flow to the plant?
11. Are major pumping costs incurred?
12. Are elaborate foundations involved?
13. Is the ground water level high?
14. Are major cut and fill necessary?

Parts of plant

A. SITE WORK

1. Cost of cut Vs fill?
2. What is the cost of interconnecting pipe lengths?
3. Does flood plain and ground water affect foundation costs?
4. Are duck bank costs for site power distribution efficient?
5. Is maximum benefits made of the existing contour?
6. Are structures with heavy loads located on good load-bearing start?
7. Is the sequence of construction hampered by deep foundations?

B. LIQUID PROCESS

1. What processes are used?
2. Can unit processes be combined?
3. How much hydraulic head is used throughout process?
4. What are the energy casts for oxygen transfer, pumping costs, chemical, etc?
5. Are the Btu values of the waste product utilized and/or recovered?

NOTES

6. Can common wall construction be used?
7. Have precast units been considered?
8. What is the cost break between using deeper tanks VS. a larger area to provide the required volume?
9. Is the flow pattern simple rather than circuitous?
10. Can non-energy (hydraulic) mixing or re-aeration be provided efficiently?
11. Are material selections cost effective?

C. SOLID HANDLING SYSTEMS

1. Can volumes be reduced in the liquid process?
2. What are energy, chemical, operation and staffing costs?
3. What is the ultimate disposal source?
4. What concentrations will the treatment units achieve?
5. Can energy be utilized from the Btu value of the sludge?
6. Is digestion feasible?
7. Can methane gas be used?
8. What is the break-point between adding chemicals and achieving a dryer sludge?
9. Can chemicals be recovered?
10. Will volume reduction of sludge save money in ultimate disposal?
11. Can storage be provided in the treatment process units?
12. Can chemical feed units be controlled to obtain efficient dosages?
13. Is heat efficiency retained by the well-insulated units?
14. Can piping and pumping systems be optimized?

D. ADMINISTRATION BUILDINGS

1. What is the function of the buildings?
2. Do contracts allow competition?
3. Evaluate space allocation and equipment orientation within structures.
4. What percentage of building space is functional?
5. Are pipe runs routed efficiently?
6. Can acoustical treatment be localized?
7. Are standard specifications obsolete?

NOTES

BUILDINGS
Total System

(a) What is in the building?

(b) What are the requirements?

(c) What is the square footage area of the building?

(d) What percentage of floor space is functional area?

(e) What is the ratio of building exterior surface area compared to floor area?

(f) What is the energy budget?

(g) What percentage of exterior surface area is functional?

(h) Are building materials suited to the locale?

A. SITE WORK

1. Are extensive utility relocations required?
2. Are cut and fill balances excessive?
3. Can sediment control structures be used in the ultimate drainage design?
4. How many parking spaces are provided per acre? Is it below average?
5. Is building oriented to achieve optimum sun angle?

B. ENERGY CONSIDERATIONS

1. Is make-up air and exhaust air minimized?
2. Can comfort levels be reduced to 68°F and 55°F where unoccupied?
3. Localize extreme loading areas such as laboratories, computer rooms, etc.
4. Use individual zone control where feasible.
5. Is heat from exhaust air recovered?
6. Is undulation sufficient? Are reflective castings used on southeast and west exposures?
7. Are hot-water tanks and piping insulated?
8. Is task lighting utilized? Can heat be recovered from lights?
9. Can two-speed motors be used to achieve efficiency?
10. Is building orientation optimum for heats?
11. Is solar application feasible?

Are high-efficiency motors cost effective (i.e., do energy savings offset premium cost)? Such questions initiate the thinking process and leads to the identification and evaluation of various alternatives.

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3.4 SUMMARY

The functional approach is a unique characteristic of value engineering. Deriving a concise description of the function to be performed is an essential step. Without ascertaining this, it would be next to impossible to assess the alternatives that can reduce cost. Value engineering is based on functional approach. A product is analysed by the function it is required to perform. Product is essentially the result of an appropriate design to perform certain primary functions. Product also has certain secondary functions. Logically, as per the value engineering concept, the cost/value of the product must be distributed between these two functions, proportional to their relative importance. Primary functions are the basic purpose of the product and/or the service. Secondary Functions are derived from design considerations. The function analysis approach has several advantages which have made it the focal point of value engineering.

The advantages of function analysis approach are it forces conciseness and eliminates fog. It identifies what the buyer wants in the form of function, not things. It distinguishes between the parts and the functional approach. It forces us to think in great depth and It helps us to communicate what we are actually doing into a more enthusiastic give or take discussion of cost versus worth. Functional Analysis Systems Technique(FAST) is a systematic road mapping of functions. Complicated process or assemblies and determinates is a step-by-step method.

Check Your Progress

1. What are the advantages of function analysis approach?
2. What is Brain storming?
3. What is DARSIRI method?

3.5 ANSWER TO CHECK YOUR PROGRESS

1. What are Primary Functions?

   Primary functions are the basic purpose of the product and/or the service. For example, consider the case of a personal stereo system(walkman). The primary function of the walkman is to reproduce recorded music.

2. What are Secondary Functions?

   Secondary Functions are derived from design considerations. If the design is based on the wiring of transistors and valves, such items provide the secondary functions.

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3. What are the advantages of function analysis approach?

   The advantages of function analysis approach are as follow:

   - It forces conciseness and eliminates fog.
   - It identifies what the buyer wants in the form of function, not things.
   - It distinguishes between the parts and the functional approach.
   - It forces us to think in great depth and
   - It helps us to communicate what we are actually doing into a more enthusiastic give or take discussion of cost versus worth.

4. What is Brain storming?

   In this technique a group of informed people who are aware of the problem are encouraged to put up their suggestions and ideas to solve the same. Environment for brainstorming session is arranged in such a way that it encourages free flow of ideas without fear or favour.

5. What is DARSIRI method?

   DARSIRI is the most common and effective technique adopted in Value Engineering. This is the most scientific method adopted. It consists of Data collection, Analysis, Recording ideas, Speculation, Investigation, Recommendation and Implementation.

CHAPTER-4

ROLE OF MANAGEMENT IN VALUE ENGINEERING

4.1 INTRODUCTION

Perhaps no one element contributes more to the success of a Value Engineering (VE) Study than its management. This is the area that influences the success of the study by determining whether the recommendations of a VE study are accepted or rejected by the owner. The end result is the benefit to the owner in cost savings or improved operation. Proper precautions in establishing the necessary communications and environment are necessary to foster a free flow of information required for an effective study.

A value engineering study involves participation between three main entities: the owner, the designer and the value engineering consultant. Unless the project is properly managed, its success will be hindered. Each participant has a role in the value engineering study. It is the job of the value consultant to ensure that all participants know their responsibilities ahead of time; are properly organized to carry out their responsibilities; that the staffing and team expertise necessary to carry out the study are provided; that the work is directed in an effective manner; and that the end product produces result that are well founded and will result in cost savings or ease of owning and operating the owner's facility.

How this task is performed and the elements that are involved are the subject of this chapter. The basis for much of the information included is from the experience gained by the authors in previous value engineering studies and workshops. Participants in 40- hour value engineering training workshop have

raised many questions about the methodology used to ensure the proper results from a value engineering study. At the same time, owners and design engineers whose projects are being value engineering have also raised certain questions and have outlined certain criteria which they feel are important to the overall success of a project.

The VE study is the actual practice or application of VE to a particular product. Those doing the VE study are attempting to reduce total life cycle costs for the subject of the study, be it hardware or software.

Simulated or actual VE studies are also frequently undertaken in the classroom, following training in VE principles. Many companies have found that by using **"live"** projects in VE training, real savings are achieved which defray some of the training expense.

The following discussion is slanted towards on-the-job VE studies. However, most of the discussion applied equally well to VE studies as classroom training exercises, which is treated as a separate subject in the next section.

The objective of value engineering is to increase the value of product.

The steps involved in carrying out the same are:

- Identification of product for VE studies
- Identification of desired quality level of product
- Identification of systems, sub-systems and components and their inter and intra-relationships to perform the function
- Identification of functions – primary, secondary and optional – of each sub-system and component
- Assignment of weightings to functions in each of the sub-systems and components
- Isolate function which are superfluous or unnecessary
- Identify alternative means of achieving the function which give better value to the product
- Identify alternate components and materials to perform which is more cost effective without compromising on the quality
- Recommend means of achieving optimum value of product
- Implement recommendation which is finally accepted

Method of Analysis

A value engineer must approach the problem with an open mind.

At the same time he should never take anything for granted. He should proceed in a systematic and orderly manner and develop a scientific approach in his analysis. He should develop facts cause-effect relationships established by analysis of relevant data through scientific methods. Different methods are suggested to conduct value analysis by various authors.

P.R. Atwood, an ILO expert, has developed a method called DARSIRI, an anagram having seven steps for value analysis. There are:

- Data collection
- Analysis
- Record of ideas
- Speculation
- Investigation
- Recommendation
- Implementation

M.S.S.Varadan has suggested five phases for this analysis namely, information, creative, development and implementation phases. In the author's opinion it is better to adopt similar methods for value analysis, as that of method study. This suggestion is made because it has been found that there are many things common between method study and value engineering as is evident from the following basic characteristics of both:

- Applied for finding better methods
- Focus on cost reduction
- Nothing is taken for granted
- Questioning method is applied
- Approach is unbiased and open minded
- Emphasis is on an analytical and logical solution
- Success based on creativity and innovative spirit of the specialists

While work study aims at finding the best method of doing a work, value engineering aims at increasing value of the product. Work study, therefore, increases, productivity and hence reduces the cost of production. This ultimately leads to lesser cost of product. Reduction in the cost of the product is also the ultimate objective of value engineering so that the customer gets maximum value for the rupee. Therefore, both these methods lead to the same objective, through different paths. The following phases/steps are recommended to conduct value analysis.

- Selection of product/activity
- Recording of relevant data
- Examination of existing design/process.
- Development of new design/process.
- Installation of new design/process
- Maintaining new design/process

Selection of Product and/or Activity

Any product and/or activity can be selected for value analysis. However, one should keep in mind that the main aim of value engineering is to provide maximum value for the money one spends for a product and/or service. Since value analysis, itself costs money to the company, every effort must be made to ensure the selection of such products which give maximum return for the effort.,

(a) Classification

Product and/or service can be classified under the following four categories, depending on the cost and volume of production.

Volume ? Cost ?	High	Low
High	HH	HL
Low	LH	LL

Following are the priorities allocated to various categories of product for value analysis:

Priority 1: HH = High cost, high volume products

Priority 2: LH = Low cost, high volume products

Priority 3: HL = High cost, Low volume products

Priority 4: LL = Low cost, Low volume products

(b) Decision Rule

- Accept all products under priority 1 for VA
- Select Priority 2 and 3 products for VA after further analysis of cost economics
- Do not select any product of priority 4 for VA

(c) Selection Criteria

These are given below:

1. The terms 'high' and 'low' mention here are relative terms. A product categorized as 'high cost' refers to the annual turnover of the company contributed by all other products. This is similar to the ABC classification in materials management. Looking at it from this angle, category 1 is akin to A class items and categories 2 and 3 are similar to B class items in the inventory.
2. VA is applied not only to a product as such but to a sub-system or component which forms part of a given product. In such a situation 'high cost' refers to components which contribute more than 10% of the cost of production. Since materials account for nearly 60% of the cost of production, 'high cost' accounts for 1/6th the cost of materials.
3. In the case of volume also it is a relative term compared to volume of other products. Cut-off volume for each category varies from organization to organization.

These rules are flexible and left to the discretion of the management. The above criteria are only for guidance. It can not substitute sound judgment of management. Products are selected for VA based on merit in each case. Management policy, cost economics of such studies, market conditions, market standing, etc. have profound influence in their selection. Some of these considerations are;

- Stage of product in the product life-cycle; this determines how long the product is likely to be on demand. There is no need to subject a product for VA if the same is getting obsolete or going out of market shortly. VA is all more preferable if product is in the design stage.
- Annual saving must be sufficient to justify the efforts and cost of VA
- In case certain complaints are received from customers, such products are subjected in VA, overriding cost-volume considerations.

Recording of Data:

Collection of relevant data and systematic recording of such data are covered in this phase. Data is the basis of information. These are of different types which are given below:

- Design parameters
- Primary/ secondary functions
- Details of components and sub-systems used, their specification, price and sources
- Details of materials used, their specifications, price and sources
- Primary and secondary functions of products, components, materials and sub-systems
- Technology –present and future trends

There is no hard and fast rule to say what data is to be collected and how much. These are left to the discretion of the specialists who undertake this analysis. More often not, this analysis is a group work. This is necessary due to rapid advancement of technology in which appropriate specialists are needed to provide the right kind of information and support to the analysis. What is however important is to ensure that data so collected are relevant. For example, misrepresentation of functions can lead to disastrous consequences.

Critical Examination of Facts

This is the most important step in value analysis. Here the relevant data and information collected in the earlier phase is critically examined and analysed.

Objectives

The Objectives of critical examination at this stage are:

- Identifying unnecessary functions and eliminating them.
- Combining common functions between various elements into fewer ones to avoid duplication and additional cost.
- Re-arranging sequences of functional activities if that can eliminate additional stages in the design and Simplifying the design to reduce system and components without reducing quality.
- Identifying components and materials which can replace costly items used in the design.

Principles

The following principles are most relevant in the critical examination. These are;

- Examine facts as they are, not as they appear to be.
- Avoid bias and preconceived notions.
- Approach the problem logically and dispassionately.

- A void hasty judgment or jumping into conclusions.
- Attend to details to get into the bottom of the problem. This will avoid prescription of simple solutions to complex problems.
- Expose undesirable aspects of the existing design before considering new methods or use of new materials.
- Save cost without sacrificing functional efficiency.

Although substitution of materials and components have greater scope in value engineering it may be possible to reduce costs by eliminating certain functions. This will automatically eliminate corresponding materials and components altogether. Therefore the focus on examination must be directed towards functions.

4.2 VALUE ENGINEERING METHODOLOGY

There are seven basic elements of Value Engineering Methodology. These elements are not always distinct and separate practices. They often merge or overlap.

1. Product Selection: Value engineering is a selective technique. Suitable projects for study are selected on the basis of high cost, complexity of product, low profit margin, life of product storage or bad delivery of parts or material, etc.
2. Determination of Function; Analyzing and defining the functions that must be performed by the selected product is not easy to come by. Any product or service has a primary function, which can be described by short, simple words. Then again, there is a function known as the 'secondary function'. Let us consider a source of light, a water pump, a clock. Here, the primary function is to provide light, pump water, indicate time. Each of these things may also have a secondary function; a light source may be required to resist shock, a pump for domestic use to operate at low noise level, a clock or watch to have attractiveness. We may take another example-an electric refrigerator has the primary function of preserving food by electrical means. The added features of easy defrosting. Storage space in the door etc., are secondary functions.
3. Information Gathering: At this stage, the pulling together of all pertinent facts concerning the product, i.e., present cost, quality and reliability, requirements, development history process sheets, suppliers name

and address, quantity/annum, life of product and any other relevant data must be written down and documented.

4. Development of Alternatives: After sufficient information has been collected and analyzed, a team of people from different functions is drawn together to generate and evaluate new ideas through 'brainstorming'.

5. Cost Analysis of Alternatives: Production costs by accurate measurements or analytical estimation to indicate the cost of alternatives is very important at the point of time, so that a selection can be made of one or more of the lower cost alternatives for further development.

There is a whole series of techniques, which identify unnecessary cost, remove obstacles and provide alternatives at minimum cost. Good results are usually obtained even by using one of the techniques but there is no hard and fast rule in the way of applying more than one technique to get desired results.

(i). Blast, Create and Refine : In this technique, the function or functions are brought into a clear focus. The possible means of satisfying the function are then expressed in simple terms. Afterwards, the necessary complexity is added.

Blast: At this stage, (keeping in mind the basic function to be accomplished, but not expecting necessarily to accomplish it entirely) alternative products, materials, processes, ideas are generated. These alternatives should, first of all, at least fulfilled some important part of the function in a very economical way; at the same time, the specific cost, involved be brought into clear focus.

Create: Using intense creativity this step should serve to generate alternative means by which the concept revealed by blasting can be modified to fulfill a large part. The increased cost which is associated with the increased function should be cleared and brought out to the notice.

Refine: In this final step, the necessary created alternatives are added to the functions including whatever in necessary, and the full cost figure worked out for the idea is that the resultant newly constructed product concept fulfils the total function with the same reliability and at reduced cost. The following example shows how to follow the three basic steps.

Let us consider a common fastener: (i) Nail. To blast a steel nail, let us compare its costs with that of steel wire of nail diameter, which is capable of doing the important function of a nail.

Create-Our next step be to create, for review, the best of alternatives which will serve the function of the head, such as: (a) bend wire at one end; (b) flatten one end; (c) weld a small piece at one end.

Refine-in refining, we must look critically at the total functions of the nail. Secondly, we should review the basic cost of the material from which the nails is made, as found in blasting. Also, we must calculate the amount of function which the wire alternatives fail to accomplish. Then we should develop ideas, with their cost, for doing the function of a nail. Having selected the low-cost practical solution, if we find that the required function is not totally accomplished with complete reliability, we must further refine by adding increments of function and cost so that the new product becomes totally usable at reduced rate.

(ii) Avoid Generalities: Do not accept any statement, unless you critically examine the reasons, "This field won't grow potato. This land is bad. It has hollow centres. Don't waste time or money trying to grow potato on it". But by specifically enquiring why it won't grow potatoes, we might find that Rs 100 worth of magnesium sulphate will make it top grade potato growing land.

(iii) Get All Available Cost: Emphasis is placed on getting meaningful costs and not necessarily those provided by inadequate (for this purpose) accounting systems.

(iv) Use Information From the Best Available Source: The source from which the information comes must constantly be weighted to ensure the utmost reliability.

(v) Use Real Creativity: Using real creativity through individual and group brainstorming and practicing the principle of deferred evaluation, quite a number of realistic and economical alternatives can be developed.

(vi) Identify and Overcome Road Blocks: it involves the identification and evaluation of precedents, established practices and prejudices.

(vii) Use Industry Specialists to Extend Specialized Knowledge: This means that a good value analyst should be diligent in consulting with other who have better specialized knowledge.

(viii) Get A Rupee Sign On Key Tolerance.

(ix) Use Vendor's Available Functional Product.

(x) Utilize and Pay for Vendors' skills and knowledge: it is necessary and profitable to consult with vendors to involve them in development work.

(xi) Utilize Specialized Processes: A value analyst should be aware of seek out new processes. A significant consideration is that many suppliers provide service rather than products and a knowledge of their special skills may not be known and must, therefore, be sought out.

(xii) Ask Yourself the Question. "Should I spend my money this way?"

6. Testing and verification by using the design or laboratory personnel, prove that the alternative(s) will not jeopardize fulfillment of performance or the functional requirements is necessary when a proposal is about to be submitted

7. *Proposal Submissions and Follow up for Implementation.* The preparation of the final proposal(s) and submission of the same is of prime importance. A simple factual proposal form with just the necessary date and savings is all that is required, because if the value engineering exercise is conducted correctly. All departments involved would have had their say and accepted the proposal.

To ensure that work is not left lying on some one's desk it is necessary for the value engineers to follow up, say, a week later to assure that the proposal is being put through or receiving attention. The value engineering effort should comprise of all seven elements that the actual savings are as specified on the proposal.

Those already acquainted with the critical examination technique will find the following questions, which are used regularly by value engineers to be comparable. They are:

- What is it?
- What does it do?(is it really necessary?)
- What does it cost?
- What is it worth?
- What else might do the job?
- What does that cost
- Which is the least expensive?
- Will it meet requirements?
- What is needed to implement?

Also available for checking purposes are check lists for use in developing alternative designs Examples are as follows;

General Questions:

- Can the design be changed to eliminate the part?
- Can the present design be purchased at lower cost?
- Can a standard part be used? etc.

Machine Questions:

- Are all machined surfaces necessary?
- Will a coarser finish be adequate?
- Are tolerances closer than they need be? etc.

Assembly Questions:

- Can two or more parts be combined in one?
- Can parts be made symmetrical?
- Can roll pins be used to eliminate remaining? etc.

Specification & Standards:

- Can an altered standard part be used instead of a special part?
- Are all threads standard?
- Can any specification be changed to effect a cost reduction? etc.

There are, of course, many other questions that need to be asked, and this depends on the individual Value Engineering set up.

4.3 APPROACHES TO VALUE ENGINEERING

VE studies may be performed by one of the following three approaches:

1. Team
2. Individual
3. Modified Team

Most VE studies are performed by teams, although it has been shown that an experienced individual can do component VE studies when provided with adequate support. In the modified team approach the individual conducts the VE study and uses team members more in the capacity of a sounding board for ideas, approaches, etc. For training purposes and for more Complex items the team approach is the most desirable means for the performance of a VE study. In all cases, individual, modified team, or team study. The same VE procedure is followed.

Team Structure

A Value engineering team usually consists of from four to eight persons.

A team size above eight persons should be avoided because the group becomes unwieldy and inefficient. The team is formally organized and appointed by a component authority for the purpose of conducting a VE study of a particular system / item or project. An experienced value engineer is assigned as one member of the VE team. The reason for appointing him as a team member is to assure that the VE method is implicitly followed. This is desirable so that project time is used to best advantage and that team members properly follow VE principles. A team chairman and a secretary are normally selected by the team members.

Selection of team members is based upon individual work experience or background and upon the technology involved in the particular project under study. Team members should have had VE training, if at all possible, prior to appointment. A typical VE study team might consist of one or more persons from each of the following areas:

1. Engineering (electrical, mechanical, aeronautical, etc.)
2. Procurement
3. Maintenance
4. Manufacturing or production (if available).
5. Quality control or quality assurance.
6. Supply or logistics.

Member Assignments

The secretary of a VE team is responsible for maintaining a record of the entire team's activities. The team chairman, if one is selected, coordinates the team effort to avoid duplication of work. Individual team members are assigned tasks commensurate with their personal preferences or abilities.

The importance of the secretary maintaining complete history of a VE study cannot be over emphasized. Quite frequently, information obtained during the study will be required for implementing the proposal. If the secretary's notes are complete, costly duplication of effort can be avoided.

Procedures

The VE study team follows the VE job plan. The team works on each phase in turn and should satisfy itself that the techniques employed in each phase are performed in a professional manner. Work elements should be assigned to individual team members, depending upon their personal capabilities. However, the team as a whole should perform the analysis, analysis, the de-

velopment of alternatives, and agree upon the cost target and the alternatives finally selected.

Judgment must be exercised by the team to determine the depth to which each phase of the job plan is performed. Because each phase of the plan is highly dependent upon the preceding phases, it is often necessary for the team to go back and perform additional work in an earlier phase. Hence, the team may have members working on two or more phases at the same time, thus causing the phase to overlap. If during the gathering of information, it requires several days to receive data on specific subject, the team should go on to another step in the job plan and return to this part of the study when the data is received.

The VE study should be completed as expeditiously as possible. The longer it takes to complete the study, the less time will be available to implement the results and to realize the savings benefits.

The study group must recommend one or more feasible alternatives. Usually if more than one alternative is recommended, the best-value alternative (one with greatest cost savings) will be presented first in the final report.

Documentation

All the data, information, ideas, designs, cost alternatives, etc., relative to a VE study should be carefully recorded by the team recorder. Project data can be best recorded in a standard VE study project workbook designed for that specific purpose. Remember that a VE study is like any other engineering study in that it should be carefully documented to convey to all concerned that everything took place during the study. All of the information in the VE project workbook should support the final proposal and recommendations.

After a VE study has been performed, it will be reviewed by the management personnel who make the decision related to implementation. All data on the study should be recorded so that these persons have all information available for favourable review of the study. The best approach to documenting the study is to record on a daily basic everything that occurred relative to the item under study.

Project Presentation

A formal written presentation (report) is always required upon the completion of a VE study. The report should be clearly and concisely written, bearing in mind that the reader will probably not be completely familiar with the item or even the technology involved. In preparing the proposal the writer should

be guided by considering the procedures used by those that will review the proposal. Remember that those who review the proposal are busy people, who want the facts on the study stated in concise format. The report must tell them what they want to know about something with which they may not be completely familiar. In all cases, the before and after situations must be clearly explained. As a minimum, the report should include:

1. The name and title of each team member.
2. A short description of the system or item studied in the form of a clear, concise and narrative description including a sketch or drawing.
3. A short description of the proposed alternative (or alternatives) in the form of a clear, concise, narrative description, including a sketch or drawing of the alternative.
4. Conclusions of those making the study based on their findings.
5. Recommendations based on the team's professional judgement including a time schedule for implementation.
6. A complete cost. Summary comparing the present item and each of the proposed alternatives.
7. Actions necessary to implement the proposed alternative.
8. A break-even analysis chart (if appropriate)

In addition to the written report, the team participants may be requested to make an oral presentation. The two main benefits to be gained from oral presentations are to create more interest in the VE programme and to afford those reviewing the final proposal, the opportunity to question those making the presentation about details of the proposal not fully explained in the written report. Format for the oral presentation should be closely parallel to the format for the written report. To assist in the oral presentation visuals, flip charts or transparencies should be prepared. Necessary visual aids for oral presentation should include as a minimum, sketches and drawings and cost summaries.

Follow-up

Once the proposal is submitted, it must be followed up periodically in order to monitor its progress. A sample form to facilitate this follow-up may be prepared. The responsible Value Engineer should regularly make a check of who has the proposal and what is its current status. Occasionally, there are delays in initiating evaluation action on the proposal. In this case, polite re-

mainders to , the responsible authority may be necessary. Follow-up notes should:

Offer help, if any further clarification of the proposal is required.

Stress that delay in project acceptance will result in a loss of savings, especially on current programmes.

As might be suspend, the preceding is meant to imply that the value engineer of VE group should never let a VE effort die because of inaction at the evaluation stage. Instead, the evaluation action should be carefully followed, with gentle prodding, as necessary, until disapproval or approval and implementation have been completed.

4.4 WHY THE PROGRAM WORKS

Value engineering is a proven management tool to ensure the cost effectiveness of design or construction projects. The program has shown excellent results in all fields of construction and manufacturing. Participants in our value engineering project studies and training seminars have been questioned about what they feel is the most effective part of a value engineering effort. They have also been asked why they feel value engineering is so effective.

The responses cover a wide range of answers; however, there are certain elements that seem to be prevalent among the responses.

1. Value engineering is a straightforward and effective approach. It uses a job plan. The job plan is a key to value engineering. Its organized approach is very similar to that of the inventive process which seeks out information, stimulates the thought process in a group and evaluates these thoughts and ideas and produces recommendations for implementation. Value engineering ensures that the free flow of information is not hampered. The pitfalls of premature criticism are detoured by separating the creative aspects of the study from the judging aspects. A value engineering project design uses engineering and architectural principles and decisions to achieve the required function at the desired cost. It further sets the standards for operation and maintenance of the facility. It also helps to determine the later impact on safety, ease of maintenance, comfort and efficiency of the final product.

Value engineering has traditionally been applied in the design stage of the project. Here the actual construction elements of the project can be viewed and analysed with specific costs placed on each item. Recommended value engineering changes are easily evaluated at this stage by the difference in quan-

tities and costs of materials as well as the labour and materials required to construct the facility. Thus far, value engineering has had its greatest impact during the design phase. Value engineering studies have successfully reduced the initial costs and energy dependence of major projects. Project design is probably one of the most difficult stages in the total facility life. At this point, speculation is turned into reality. Here, actual facilities are being designed. Yards of concrete, tons of steel, brick and motar and other physical materials are combined for the final end product. Literally millions of details must be considered in combination with site limitations in order to arrive at an end product. Indeed, the task of the designer is challenging, whether he be an architect or an engineer. As discussed in previous-chapters, the design engineer is a true inventor and a true creator. The task of the designer is probably the most difficult task in the total facility.

Bidding and Construction Phase

The bidding stage is when the plus and specifications are advertised to allow contractors to prepare an estimated cost for constructing the facility. Plans and specifications are interpreted by the contractor and a price determined for the cost to build the facility. It is obvious that the completeness and thoroughness of the plans and specifications help to avoid any grey areas that might be open to specification once the contractor beings the job. Contractors usually base their bid price on quantity take-offs and actual quotations for furnishing and installing materials of construction. A contractor in determining a cost for construction has analysed the material costs, the labour cost and methods of construction that will give him the best competitive edge in the bidding process.

Value engineering can play an important part in the construction phase of the project. Many municipal and government agencies allow value engineering sharing clauses as a part of their contacts for construction. These clauses allow the contractor to share in the savings of money as a result of recommendations to reduce the cost of the facility. As an example, the contractor may propose a different type of material for the roof of a building. The material provides the same insulating properties; however, it can be obtained and installed at a savings of $100,000. The contractor can participate in instant savings based on a percentage of the initial savings and a collateral savings. Collateral savings are based on a percentage of the owning and operating costs. As an example, if a contractor makes a recommendation that he well save money in future years of operating the facility, he may be entitled to a per-

centage of the savings for the first year of operating the facility. These means of sharing in savings from ideas are called contractor-incentive-sharing clauses. The amount of savings and the regulations for submittal vary. Contractors should be aware of the potential in these areas when they bid a project.

The biggest drawback experienced thus far in using contractor-incentive-sharing clauses have been in the long delays experienced by contractors in receiving approval of their recommendations. The delay is often the result of incomplete submittals on the part of the contractor. In order to evaluate a contractor-incentive-sharing proposal, a complete idea of what the contractor is proposing, how it impacts the project, the specific differences in the original and the proposed design, a detailed description of the comparison costs, and the impact on the total schedule of the construction of the project should be explained. In most cases, however, the time delay attributed to contractor-incentive-sharing clauses is involved in the red tape of the various review agencies.

Facility Operation Phase

Operation and maintenance costs began to soar within the last decade. The increase in cost of energy, and inflationary increases in labour and material have brought about an awakening to public ad private plant owners. More and more emphasis is being placed on reducing the maintenance burden and easing the operating costs of a plant or building facility. Operation and maintenance costs are continually increasing throughout the life of the project. They will fluctuate from year with inflation and with the escalating costs of fuels, chemicals, lubricants and other supply materials. While operation and maintenance costs escalate, the construction cost is fixed. In many cases, the advantages of investing money during initial construction will result in operation and maintenance savings throughout the project life. In terms of value engineering, it is best to evaluate the operation and maintenance aspects of a facility during the design stage so that the characteristics of the facility can be changed or altered accordingly.

Can value engineering be applied to plants that are already operating? The answer is a resounding "Yes." The approach in this case focuses on the Value Engineered Energy and Resources. The same tools of the value engineering job plan are applied: energy model (power, fules, etc.); resource modeling (accounting of staffing, chemical, maintenance and benefit costs); functional analysis and the multi-disciplined team approach. The chemical, maintenance and benefit costs); functional analysis and the multi-disciplined team

NOTES

approach. The chemical and process industries have been successful in reducing costs of production and increasing their profits. In these cases, the total costs of the plant operating are evaluated.

It is the option of the authors that the best place for value engineering is in the planning and design stages. The major reason is of course, that if the owner and not shared with the contractor. The other element involved is the time frame. Contractors make their highest profits when they can start a job, follow the schedule rigidly, finish the job, and move off the site. In many cases, the savings that could result from a value engineering incentive clause may be eaten up by having to reschedule construction events and alter the scheduling of the project. Unless the savings is substantial, contractors are usually not willing to take the risk.

Check your progress

1. List the steps involved in carrying out the VE studies.
2. List the phases/steps that are recommended to conduct value analysis.

4.5 THE COST OF A PROJECT:

Planning, developing and constructing a project in today's marketplace is involved and often a lengthy task. Rigorous and complex regulations and standards add to the difficulty and the cost Input into the design from the owner, engineer, contractor and the operation and maintenance personnel comprise a large matrix of people that influence the design and eventual cost of a facility.

The main impact comes from the owner of the facility who sets the requirements and objectives of the project. The owner has a certain function to perform and an idea of the size of the facility. The design engineer interprets these requirements and develops them into a workable solution. The designer impacts the construction cost and the operation and maintenance costs. The contractor impacts the project by the cost required to build the facility and the resultant quality of construction. The quality of construction and life-span of the facility are due to the contractor's skills. Operation and maintenance personnel must keep the facility running. They are required to operate the plant given to them, or to change it. Their maintenance skills and perseverance are key factors that influence operation, of equipment, and cost. The value engineer also influences the cost of a project. His input into the design saves money in both the areas of construction costs and the total life-cycle costs of the facility.

In many federally funded projects, the regulatory agencies are involved. As an example, the regulatory agencies of the U.S. Environmental Protection Agency and the state health departments, which set strict standards, greatly

influence the costs of wastewater facilities required to meet stringent effluent guidelines. The impact of the major decision-makers on facility cost will be significant. As can be seen, the using agency has the greatest impact, as they set the overall criteria for the project. The architect-engineer also influences the project to a great extent because their design impacts the construction cost and the operation and maintenance cost throughout the list of the project. The initial contractor influences the costs by the bid price. However, that bid price is a one-time cost in the life of the project. Operation and maintenance personnel are forced to operate the facility. Therefore, their actual impact is small; however, it is stretched over a long period of time.

4.6 WHEN IS THE OWNER READY FOR VALUE ENGINEERING?

An owner's decision to employ value engineering on a project is difficult. An engineer or an architect is selected to design the facility, and it is hoped to design it at the optimum cost. The owner has spent much time and effort in arriving at a proposed plan and has certain criteria to be met. The designer is vigorously employed working on the project trying to get all the details pulled together during the planning stage so that he can progress rapidly into design. At this stage, there are many details to be brought together. It is often difficult to sit back and take an overview of the project to make sure that the designer is, in fact, on the right road.

We have found that value engineering is best employed as an overview of the total planning process and during the actual design stage of the facility. The planning stage offers an opportunity to analyze the conceptual ideas and the conceptual thinking for the project. At this stage, the value engineering team has the advantage of not being tied closely with the project. They have an objective viewpoint. They can and should review the project without being overburdened by the critical schedules and outside influences of the design concept. Value engineering applied during the planning stage also allows an opportunity to make changes without affecting the cost or the schedule of the project. Value engineering, in this case, is a second look, and has shown itself to be effective in yielding savings to the owner.

As the design progresses, value engineering should also be applied in the design stage of the project. It has been our experience that value engineering is best applied in a two-step approach at the design stage. One study should be employed at the point where the basis for design has been developed. At

this stage, the value engineer is looking at the design criteria for the process; the layout of the facility on the site; foundation condition; the physical layout of the facilities, space allocations; functional areas required for operating the facility; the theory and concept for operating and controlling the facility; the electrical one-line diagram and system design; the architectural concept to be employed for the project; climate and comfort control levels and corresponding heating; ventilating and air-conditioning conceptual design; building layout; and other factors that help to show the overall concept of the project. Value engineering at this stage of design is usually employed when the project is approximately 20-40 percent complete. The value engineer should state in specific terms what areas he wishes to evaluate to ensure that the designer and VE consultant agree on the level of completion of the project.

A second value engineering study is conducted at approximately the 60-80 percent design completion stage. At this time, the value engineering team is interested more in the construction elements of the project. It is very difficult to evaluate process, layout and concepts for the design during the second study because, at this stage, working drawings are nearing completion. Major changes to the design at the 60-80 percent stage would cause delays in the scheduling of the project. High cost for redesigning and redrafting would also occur. The team's focus is on construction procedures, configurations, materials of construction, construction operations, instrumentation and control, mechanical equipment, electrical control and instrumentation and on analyzing very closely the impacts on the operation and maintenance of the overall project. The owner's staffing requirements should also be analysed as an input to the overall operation costs of the project. Staffing requirements should be made jointly by the owner and the value engineering team. The specifications for the project are the most important part of the second value engineering study. Often overlooked is the high cost in the specifications that instruct the contractor in the material and equipment as a part of the second value engineering study.

Having, determined that the owner is interested in employing value engineering, the next step is to determine how value engineering should be conducted and to select the appropriate value engineering staff.

4.6.1 Selecting a VE consultant

Value engineering is a systematic approach at identifying and removing unnecessary cost in a project. The key elements to the success of a value

engineering study are knowledge and experience in the field of value engineering, coupled with the technical expertise in the area of study. Each of these rudimentary elements is an important aspect in the success of a project study. As a rule, the participants in value engineering study should not be associated with the original design. Team members specifically should not have participated in the original design. The reason for this is that the original designer is often biased in his viewpoint when analyzing a value engineering alternative Obviously, the designer's input and experience in the factors leading to the design are important and he should be asked to provide input on background of the project. The designer should also have input on the evaluation of VE recommendations as they develop.

There are several criteria that should be used in evaluation and selection of a value engineering consultant. The criteria, of course, follow the guidelines that would be used to select most consultant services.

1. Experience in the field of value engineering. Proper application of VE methodology.
2. Technical experience (design, construction, operation, etc).
3. Past record of performance on similar projects.
4. The approach to the value engineering work.
5. Avoidance of conflicts, especially competition with the designer.
6. Results of past value engineering studies, including implemented savings.
7. References on past projects.
8. Ability to work with the designer and the owner as team on the project.
9. Ability to perform value engineering study on short notice and to provide a quick turnaround time so that project design may remain on schedule.

4.7 Staffing and Structuring Teams for a VE Study

One question often asked is, how does one properly organize and staff a value engineering study? The subject needs to be addressed because of its importance and eventual impact on the success of a value engineering study. Far too many studies are conducted with individuals lacking an understanding of the application of value engineering. While these studies save money, they may omit areas that would have been found using sound value techniques, for

staffing a study. However, we would like to share some of the logic that has been used in the development of project study teams.

A successful VE study of a facility requires a knowledge and expertise in the technical field of study and a solid background in the principles of value engineering. It has been our experience that selecting individuals without prior VE experience sets the team back. Most people when they think of saving money envision reducing the cost by removing a part or cheapening the material. Therefore, when an engineer or an architect without VE training is selected, their initial response is to do a design review and find the apparent cost-cutting areas. In contrast, it is apparent that a study with a high level of VE talent and technical background will produce effective results.

Level of Training

Team participants in a project study should have a 40-hour value engineering training course as a minimum requirements. This places everyone at an equal footing when starting a study and allows for each participant to be actively employed on the study. Special consultants are sometimes used in a VE study because they are experts in a certain field. These people are often doctoral level and are hard to get to a 40-hour training seminar. One has to make the decision of the importance of the added expertise versus their experience in value engineering.

Value engineering training workshops are conducted by a number of sources. A VE training seminar should be one that is conducted by a certified value specialist and recognized by the Society of American Value Engineers (SAVE). Value seminars are also taught in the manufacturing field, and it is important that one recognizes the area the workshop emphasizes.

Many government agencies will require a varying level of value engineering training, depending on the size (cost) of the project and its complexity. In computing the cost-to-benefit ratio, all costs are projected to a present-worth status. The costs represent the present-worth cost of owning operating the facility. The benefit received from the facility' represents the present worth of total benefit as a result of constructing the facility. It can be seen that the cost-to-benefit ratio 0.87 makes the project a worth while venture. The cost-to-benefit analysis is one method that used in the Project Conception Phase to analyze whether a project is worth further consideration and planning. Other factors besides cost may also influence this decision.

Project Planning Phase

Planning of a project or a facility is a stage where the conceptual idea is developed further in r a workable solution. Planning is the setting of objectives and goals required to meet a given requirement. Planning takes the conceptual idea and develops it further to ensure that a project is realistic, and to also obtain direction as to what approach should be applied. Planning is deciding in advance what to do, how to do it, and who is to do it. Planning bridges the gap of where we are and where we want to be. In the engineering field, and more particularly the facilities under construction, planning is also a stage of setting objectives. It encompasses the setting of parameters, the financial aspects of various site locations, the size of alternative solutions, and a myriad of other areal r that are required to meet the objectives of the project. It helps to establish the size of the facility it analyses the physical characteristics and limitations of the particular site under question. The environmental impacts of the facility and surrounding area, it establishes the basis for physical embellishments of the building facilities, its budgets for the cost of construction and the eventual impacts of operation and maintenance of the facility, it is the mechanism that will determine the total scope of the eventual facility being constructed. The plans and specifications for construction will usually be prepared on the basis of the planning report. It also helps to assure the owner that his project is, in fact, feasible.

The importance of planning cannot be overlooked in the overall scheme of a project. Value engineering has a real impact in the planning stage. Major impacts on the life-cycle cost of a facility are usually determined at this stage of the project. As an example, the sizing of a major water facility would likely be done during the planning stage. The need for such a step would become evident during the conceptual stage of the project. The planners would identify that basic area of need and would locate several potential sites for a facility. The next step would be to determine the facility size. This determination often has the greatest impact on the total cost. If it is overdesigned, excess funds are being expended unnecessarily. However another expansion may be necessary further down the road. Its process flow scheme and method of operation is set. The process of the facility, usually have the greatest impact on co-operating the facility.

Value engineering is a likely candidate for the planning stages of a project. It is increasingly applied earlier in the project because this is where major decisions on the overall scope and design changes are made. Once the project

moves further into design development, it is more difficult for major recommendations that are centered on planning. In the planning stage of a project, the scope and objectives that are established must be compatible with the overall needs of the company or the owning organization. E.g., a project may be seen in the illustration of a master plan for an industrial plant, the planning stage, the owner outlined the requirements for the project. These needs were raised and formed the basis for the design. The next step was to determine and locate a site for physical facilities. One such site was the 1300 acre plot southwest of Waterloo, Iowa. A consultant was retained to do a site analysis and master plan for the specific site. The owner's specific objectives and the site limitations were analysed to determine the most compatible makeup of facilities with the Ie site constraints. The site analysis is an excellent graphic example. It illustrates the areas in the site most suitable for development. It shows the impacts of surrounding areas, the reliable utilities to the site, access and egress for traffic control, the location of the site in relationship to other strategic facilities, and the areas within the site that can be used to meet the owner's objectives. The valley edges set the limits of development while the topography of the site establishes the orientation of the complex allowing the perimeter to be restored to a cropland . At this point in the project, a value engineering study may be performed. A physical plan and preliminary building plans with costs with costs allows the value analyst to equate function and cost for an effective effort.

Project Design phase

The actual project design takes information from the planning stage and develops it into a set of plans and specifications to allow the project to be built. The design stage determines the actual materials in construction, the configuration, comfort levels, space utilization, process design, mechanical processes, the control and operation of the facility, the site layout, drainage. we should not ignore the psychological impact of the workers and surrounding public. It interprets the objectives and outlines procedures at conceptual stages, and shows how they can be made into workable solution.

A project design uses engineering and architectural principles and decisions to achieve required function at the desired cost. It further sets the standards for operation and maintenance of the facility. It also helps to determine the later impact on safety, ease of maintenance, and efficiency, of the final product.

Value engineering has traditionally been applied in the design stage of the project. Here actual construction elements of the project can be viewed and analysed with specific costs placed each item. Recommended value engineering changes are easily evaluated at this stage by difference in quantities and costs of materials as well as the labour and materials required construct the facility. Thus far, value engineering has had its greatest impact during the design p Value engineering studies have successfully reduced the initial costs and energy dependence of ma1 projects. Project design is probably one of the most difficult stages in the total facility life. At point, speculation is turned into reality. Here, actual facilities are being designed. Yards of caner tons of steel, brick and mortar and other physical materials are combined for the final end product. Literally millions of details must be considered in combination with site limitations in order to at an end product. Indeed, the task of the designer is challenging, whether he be an architect or engineer. As discussed in previous-chapters, the design engineer is a true inventor and a true creator. The task of the designer is probably the most difficult task in the total facility.

Bidding and Construction Phase

The bidding stage is when the plans and specifications are advertised to allow contractors to prepare an estimated cost for constructing the facility. Plans and specifications are interpreted by the contractor and a price determined for the cost to build the facility. It is obvious that the completeness and thoroughness of the plans and specifications help to avoid any grey areas that might be open to speculation once the contractor begins the job. Contractors usually base their bid price on quantity take-offs and actual quotations for furnishing and

Value engineering can play an important part in the construction phase of the project. Many municipal and government agencies allow value engineering sharing clauses as a part of the contents for construction. These clauses allow the contractor to share in the savings of money so as to reduce the cost of the facility. The material provides the same insulating properties savings of $100,000. A contractor is determining the labour cost and methods of construction that will give him the best construction. He plans to have lowest material cost, follow the schedule rigidly, finish the job, and move off the site. In many case savings that could result from a value engineering incentive clause may be eaten up by having rescheduling construction events and altering the scheduling of the project. Unless substantial savings are anticipated , contractors are usually not| willing to take the risk.

A second value engineering study is conducted at approximately the 60-80 percent design completion stage. At this time, the value engineering team is interested more in the construction elements of the project. It is very difficult to evaluate process, layout and concepts for the design during the second study stage. Construction procedures, configurations, materials, instrumentation and control, mechanical equipment, electrical control very closely the impacts on the operation and maintenance of the overall requirements should also be analysed as an input to the overall costs .The Staffing requirements should be made jointly by the owner and the value engineering team. Specifications for the project are the most important part of the second value engineering study. Often overlooked is the high cost in the specifications that instruct the contractor in the machinery and equipment to be used and the construction procedure. Having determined that the owner is interested in employing value engineering the next is to determine how value engineering study should be conducted and to select the appropriate value engineering staff.

Selecting a VE Consultant is based on the following;

1. Experience in the field of value engineering. Proper application of VE methodology.
2. Technical experience (design, construction, operation, etc).
3. Past record of performance on similar projects.
4. The approach to the value engineering work.
5. Avoidance of conflicts, especially competition with the designer.
6. Results of past value engineering studies, including implemented saving
7. References on past projects.
8. Ability to work with the designer and the owner as a 13.
9. Ability to perform value engineering study on short no so that the project design may remain on scheduled

Staffing and structuring teams for a VE study

One question often asked is, how does one properly organize and staff a value engineering study. The subject needs to be addressed because of its importance and eventual impact on the cost of a value engineering study. A successful VE study of a facility requires knowledge and expertise in the technical field. It has been our experience that selecting individuals without prior VE experience sets the team back. Most people when they think of saving

money envision reducing the cost by removing a part or providing a cheap material. It is apparent that a study with a high level of VE talent and technical background will produce effective results.

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Team participants in a project study should have a 40-hour value engineering training course as a minimum requirement. This places everyone at an equal footing when starting a study and allows for each participant to be actively employed on the study. Special consultants are sometimes used in a VE study because they are experts in a certain field. These people are often doctoral level and are hard to get to a 40-hour training seminar. One has to make the decision of the importance of the added expertise versus their experience in value engineering.

Value engineering training workshops are conducted by a number of sources. A VE training seminar should be one that is conducted by a certified value specialist and recognized by the Society of American Value Engineers (SAVE). Value seminars are also taught in the manufacturing field, and it is important that one recognizes the area the workshop emphasizes.

Many government agencies will require a varying level of value engineering training, depending on the size (cost) of the project and its complexity. Recommendations on the varying level of VE experiences are usually specified by the government agency or owner. As an example, the US/ Environmental Protection Agency may require that the team coordinator have completed at least two VE studies, and the members each have completed a 40-hour training workshop.

Selecting VE Team Members

Some are motivated or prompted by the free flow of ideas and the discussion. Not all individuals are alike in their personality, their ability to communicate perception of ideas and their ability to put their ideas into saleable products. Research has shown that individuals might be categorized in three types:

1. Idea people
2. Communicators
3. Developers and organizers

Obviously, all these talents are needed to mould the team into a productive group.

Idea men contribute heavily to the success of a VE study, as their concepts form the recommendations for cost savings. Will Rogers once said that we could get rid of all the submarines in World War I by boiling the oceans. Will was obviously an idea man. A VE team needs idea men who can suggest new combinations of materials, new layouts, optimised utilization of energy and other areas of potential savings to the owner.

Communicators are the individuals in a study who relate available information, background of a building, mechanical system or piece of equipment that allows comparative that force us to go beyond our normal thought process. Newman and Summer said that communication is the exchange of facts, ideas, opinions or emotions by two or more people. Communication is one element that makes group studies effective.

Developers and organizers are the people that put words and concepts into reality. Development of ideas is important and many good ideas are killed because they are not presented completely. Developers ensure that recommendations are presented and sold, it has no basic value to the owner.

A diversity of talents and expertise are needed for a study. Providing the information exchange of thought speculating on a solution and developing the concept into a workable solution are essential requirements of the VE study.

Larry Miles identified eight essential qualifications for value work :

a. Knowledge
b. Imagination
c. High degree of initiative
d. Self-organization
e. Personality
f. Cooperative attitude
g. Experience
h. Belief in the importance of value

Value Engineering Team Coordinators (VETC) are given the responsibility of organizing and leading the value engineering studies. The VETC is the cornerstone of the project. The VETC's duties include: (1) Deciding on the number of VE teams and the disciplines necessary for each study; (2)assigning team members; (3) coordinating the study schedule with the owner and designer; (4) managing the designer VE consultant/owner relationship; (5) leading the study team through the job plan

(6) organizing the oral presentation of results; (7) preparing the VE report; and (8) assisting the owner and designer in the implementation of VE recommendations. Value coordinators should have a great deal of experience in the techniques of value engineering and should have strong leadership and communication capabilities. To ensure that VE principles are followed it is beneficial to utilize services of a Certified Value Specialist (CVS).

A CVS is registered by the Society of American Value Engineers (SAVE) to perform value work. The registration ensures a high level of expertise in the application of value techniques.

Multidisciplinary teams

A multidisciplinary team has proven to be the most successful structure for a value engineering study. The exchange of ideas and knowledge from other disciplines provide an objective analysis Of the project design.

Anomalies frequently arise in a value engineering study. It is often the architect or structural engineer that will generate ideas that are part of the project, but not in their field of study. Why? Because many of the solutions that we use are based on our habit solutions and not on objective thinking. Value consultants have found that many firms operate through design divisions. Structural work is performed by the structural division and the electrical work by the electrical division. Often these divisions do not communicate. Experience has shown that just having all the project disciplines together will enhance the design because each discipline will have its respective impact on the total plant design. The importance of objectivity is evident in the example previously cited.

Project staffing for a value study can best be illustrated by an example of a past project.

The City of Oklahoma required value engineering on their North Canadian Waste water Treatment Plant. The facility was planned for an ultimate expansion to 80 million gallons per day (MGD). Forty MGD was under construction at the time of the study. The scope of the engineering study included the next 20 MGD incremental expansion to bring the design flow up to 60 MGD. Solids handling facilities were also a part of the study.

It was decided that two value engineering studies would be conducted; one at the 20 -30 percent design completion stage and one at the 60-70 percent stage. The first study analysed conceptual design, including such things as layout, process, equipment selection, hydraulic profile and conceptual designs for architectural, electrical and mechanical systems.

The objective of doing one study early in the design is to recommend changes early so the impact on schedule and redesign effort is not as critical. The second study analyses the working drawings, paying special attention to equipment design, architectural features, piping and mechanical design lay-outs, lighting, primary and secondary power distribution, energy and fuel utilization , structural design development and economic comparisons for construction.

VE Study Teams - North Canadian Wastewater Treatment Plant

The study teams for the North Canadian Wastewater Treatment Plant were as follows:

Study A - 20-30% Completion (Conceptual Design)

Team 1 - Certified Value Specialist

Sanitary Engineer

Landscape Architect

Sanitary Engineer

Structural Engineer

Owner's Representative

Team2

Team Coordinator/Certified Value Specialist

Sanitary Engineer

Cost Estimator

Electrical Engineer

Civil Engineer

Chemical Engineer

Study B-60-70% (Design Completion)

Team 1 Team Coordinator

Mechanical Engineer

Sanitary Engineer

Cost/Construction Estimator

Owner's Representative

Team 2 Team coordinator

Structural Engineer

Electrical Engineer

Civil Engineer

Architect

Mechanical Engineer

Selection of team members must fit the specific requirements that are pertinent to the project being studied. If unusual foundation problems are evident, a soils engineer should be included on the study . Other specific expertise should be provided accordingly.

An example of a value engineering team for a bridge might comprise the following.

VE Study Team - For a Bridge Design

1. Value Engineering Team Coordinator
2. Structural Engineer/Bridges
3. Foundation Engineer
4. Civil Engineer/Transportation
5. Construction Engineer

An important aspect of the total life-cycle cost over the life of a project is the operation and maintenance of the facility. Operation and maintenance considerations are a necessary part of most project studies. On a wastewater treatment plant, the input of the plant superintendent or chief operator is necessary, as the operation and maintenance may cost more over the project life than the original cost of the plants.

Studies on power plants may require the maintenance engineer and operations supervisor. Studies on buildings may benefit from having a stationary engineer on the study team.

In addition to the operations and maintenance personnel, the owner is encouraged to participate, as he has an overview of the total project needs and cost constraints.

4.8 CONDUCTING A VE PROJECT STUDY

Success of a value engineering study depends heavily on its organization and management. In many cases, owners and design engineers are not familiar with value engineering and how it is performed. Their first impression is that someone is looking over their shoulder and often picking at their design. Another concern that runs through a designer's head is that the engineering consultant might purposely be critical of a design in an effort to sway the own

future projects. The integrity of the project schedule that may result as part of the value engineering effort is another monumental concern. One can see how both of these concerns are delicate that they must be handled properly.

In any value engineering project study, whether it be during the planning, design, construction or operation stage, it is important to remember that the value engineering team is a part of overall project and their goal is very similar to that of the design engineer: to ensure that the owner receives a well-designed facility with the required balance between cost, performance and reliability. In reality, the value engineering consultant is a great asset to the design engineer for a project, efforts to identify alternate solutions to a problem will benefit the overall project. Remember the design engineer and the owner has the final word on adopting value engineering recommendations. The design engineer and the owner still have the responsibility for the final design of the project.

The value engineering consultant must not lose sight of the fact that the design engineer has been involved in the project for a long time. Many comparisons and valuations of alternative processes and design concepts have been prepared. The designer will undoubtedly feel that the project is his pride and joy.

The task flow diagram which outlines the primary steps of a value engineering study. The study can be viewed in three separate phases: (1) the Prestudy Phase, (2) the Project Study Workshop (3) the Post VE Study Procedure. The Pre-study Phase is the period of time used to familiarize the value engineering consultant with the project to be studied; to familiarize the design engineer with the value engineering process and procedure; to delineate the information needed for the study, and to arrange for the logistics and the setup for the actual workshop session. The Project Study Workshop Phase where the actual value engineering effort takes place. Usually a value engineering workshop lasts for a set period of time in which the value engineering team meets together and applies the job plan to develop the alternatives for consideration.

The Post-VE Study procedure Phase follows the value engineering workshop. During this phase of the project study, necessary report and evaluation of the recommendations are made, and efforts to implement recommendations are brought forward. Follow-up and accounting of implementation results are also beneficial.

PRE-STUDY PHASE

Getting off on the right foot on a VE study is akin to starting a new job. Laying out the responsibilities of each participant will lead to a well-coordinated effort. We have found that this can be handled in an orientation meeting jointly with the owner, the design engineer, and the value consultant. At this meeting, the value engineering team coordinator should outline the entire value engineering process. It is important to remember that in many cases, this will be the designer's and owner's first exposure to value engineering. The designer is perplexed, realizing that the value consultant is evaluating his project. There will be many underlying fears and questions that should be addressed in this session.

One of the most important concerns to the design engineer will be the schedule for the value engineering work. The value engineering schedule must fit very closely with the designer's schedule. The value consultant realistically must accommodate himself to any changes to the designer's schedule. Should there be delays in the project, the value engineering consultant must adjust his schedule accordingly. While discussing the subject of schedules, it is appropriate to mention the longevity of the value engineering effort. Once the designer has scheduled a date for the project study workshop, the consultant should establish the schedule for the balance of the VE effort. Submittal of design data, preparation of cost and energy models, review time and schedule for completion of VE reports must be set. This time frame should be compressed as much as possible. Keep in mind the primary objective during the design phase is to get the design completed. Therefore, the value engineering effort should be handled in a most expeditious manner.

At the beginning of the VE workshop, the designer is asked to make a presentation outlining the steps taken during the design development stages. To assist the designer, the VE coordinator should outline a format for the designer to follow. The format will outline the key steps which could be covered in the designer's presentation. It is not to say that this is a rigid outline, but it helps the designer to understand more clearly what the value engineering team is looking for.

The value engineering study is an abbreviated effort in terms of the total scheduled time for the design of the project. The value engineering team must, therefore, quickly familiar with as much information on the project background as possible. The team coordinator responsible for collecting design information as well as plans and specifications for the project. An outline of information required for a value engineering study is already given.

Bringing together a group of highly skilled design professionals for an extended period is an obvious challenge. First, pulling skilled technical people from their normal assignment and extending their time is not profitable. Second, most designers are interested in doing knowing best, that is, designing the project. Their specific interest may not be to corroborate an- value, but to ensure successful performance. The VE coordinator conducting the works to manage and coordinate the session to ensure an open and free exchange of ideas assimilate the ideas into specific recommendations to the owner and the designer.

Another concern of the VE team coordinator is to bring together the designer's knowledge background of the project, the owner's history of the existing plant, and the specific purpose of the project. During the workshop session, the designer is asked to submit his design for review - both the owner and the VE team. Maintaining flexibility and performance are the primary objective of the designer. The owner wants a final product to meet his requirements and to yield the potential benefit to the taxpayer, user agency or company. The VE team is interested in providing better project, and, at the same time, in saving money. The common denominator is that the project meets the functions required by the owner at the lowest life-cycle cost commensurate with the owner's needs.

The value engineering job plan previously outlined forms the framework - VE workshop. The team coordinator must be familiar with the techniques of VE required by the plan. The VE team coordinator must disseminate data on the project design to team members prior to the study and lead the| workshop session keeping it on course and on schedule.

At the beginning of a VE workshop session, there is a joint meeting of members of the design team, owner representatives and the VE team. It is helpful for the VE team coordinator to outline the steps to be taken in the workshop session. High-cost and high energy use areas should also be described as a result of preparation of the cost model and the energy model. It is also wise reassure the designer that the VE team is interested only in improving the project. It helps to

Relate to the designer while in the owner's presence that all projects have unnecessary costs no matter which design firm has been preparing the project. The thrust of the VE workshop is very similar to a second look at the project.

Another major concern of the owner and the designer will be the impact of the VE workshop effort on the schedule for design completion. At the beginning of the workshop session VE team coordinator should be prepared to outline the scheduled dates for the completion of the workshop sessions, the submittal of design recommendations to the owner and the designer, the schedule for oral presentation of results and the timeframe for submittal of the VE report by the value consultant. The designer's responsibility for each of the VE recommendations should also be coordinated.

The mood of the value engineering workshop is usually set during the first half-hour of the workshop. It is, therefore, very important that the coordinator take the proper steps in order to ensure an efficient and compatible start. Starting on a firm foundation will ensure a stable ground upon which to build. A project description and presentation by the designer can often provide the missing link that the VE team members need to understand and to appreciate the background effort the designer. In every project, unusual circumstances will be responsible for influencing project signs. As an example, during the public hearings for environmental impact statements on a wastewater treatment plant, the community, may have set unalterable stipulations on the design, pertinent correspondence between review and regulatory agencies help to illuminate and justify design decision. The designer's presentation should include as a minimum, a description of the project's physical components, rationale for the design, a review of how the design evolved, description of design criteria, alternative solutions investigated, owner and regulatory agency requirements and important factors that have influenced design decision making. An outline of information that might be used for a designer's presentation is included. The designer should be available throughout the study for questions that may rise about the project.

Upon completion of the designer's presentation, the VE team should be encouraged to question the designer and the owner about any questionable aspects of the project design. All members of the VE team, the design team and the owner's representative are encouraged to participate freely in discussion of the project design. Upon hearing the designer's presentation, the VE team may want to revisit the site to analyze any questionable areas and to become more familiar with the particulars of the plant design. This initial phase of the VE study, along with the time spent during the pre-study phase in evaluating back ground information is of great benefit to the VE team in becoming familiar with the project in a short time. Further investigations into the

project cost and energy model, as a result of the designer's presentation may reflect new information.

OUTLINE FOR VE PRESENTATION

The designer of a project has been actively employed in the planning and design of the project to be value engineered. He has spent a great deal of time and effort in comparing alternatives.

The design has also been influenced by outside input during public participation meetings, in preparing environmental impacts, and from requests made by the owner and regulatory agencies and other sources. The value engineering team needs to know this data to get an idea and a flavour for factors that influence the design. The objective is to avoid duplication of efforts and to aid the team becoming familiar with the project.

To achieve this objective, the designer is asked to give a presentation at the beginning of the VE workshop session. To assist the designer, we have outlined information that, as a minimum should be addressed.

1. Scope of the Designer's effort
2. Participating Firms
3. Projected Flows
4. Effluent Criteria
5. Effluent Characteristics
6. Existing Site Conditions
7. Regulatory Requirements
8. Basis of Design
9. Rationale and Steps in Development of Design
10. Design Concepts for Architectural, Structural, Mechanical, Electrical, Controls, etc.
11. Methodology of Operation
12. Pertinent Information from Public Participation
13. Constraints Imposed by the Owner
14. Appropriate Codes
15. Explanation of Information Provided by Designer
16. Summary of Cost Estimate.

The outline is provided to aid the designer. The presentation is the Designer's responsibility and he may conduct the initial presentation the way

he feels is most comfortable. Remember that there will be other people involved in the presentation so that graphics, slides, view graphs etc., should be planned accordingly. Refine both the cost model and the energy model wherever appropriate.

The next step in the VE study is the functional analysis. During the function analysis remembers to start with the total system first before analyzing the functional components. The function analysis is setup to stimulate the creative process. By analyzing the project in terms of function, the team is forced to think beyond its normal thought processes. Caution should be exercised at this point in the VE study about skipping over the function analysis step. Our experiences showed that the function analysis sets the stage for the creative session which follows. By analyzing the function of the total plant and each of its component parts , the VE team will become intimately familiar with what the plant is supposed to do and alternative ways of performing that function. Apportioning costs associated with the function gives the team a framework for comparison. Speculation of the worth of each of the functional areas forces the VE team to think of new and different ways of providing that function. Each new method then becomes a potential creative idea. Remember that Kettering started outside the bounds of the normal solution when he designed the self-starter for the automobile. This may be true for your project. Don't be inhibited by what you see on the plans, look beyond that solution for new and exciting concepts.

During the information and creative phases of the value engineering workshop, the VE team may feel pressure to complete the study. They feel as though they should jump ahead to development of ideas. The information and creative phases of the job plan are important. Time saved in the earlier stage of the project will result in even more significant time savings later on during the development and implementation phases.

If the VE team is involved in a very complex project, it may be appropriate to use the functional analysis systems technique (FAST) to simplify and to clear up any difficulties and questions the VE team may have about the design. The functional analysis systems technique is a technique used to organize the functional elements of a project. It is a road map of functions used to delineate clear understanding of how the project functions.

To ensure some balance of order in the value engineering workshop session, the VETC may designate one of the team members, preferably one with

good handwriting, to record the steps followed in the value engineering procedure. In this way, background data will be retained for eventual use in the VE report. The project scribe should also be charged with the responsibility of recording each VE idea that is suggested by the team members. Although the team should refrain from jumping immediately into the creative idea listing, there will be certain ideas that will crop up during the early information gathering part of the project. Make sure these ideas are captured in writing so they are not lost. Remember that in each idea the potential exists for major savings.

Next, the VE team moves into the creative phase. The creative phase is one of the more interesting parts of the VE study. All team members are asked to participate in the VE creative phase. The team is looking for a quantity of ideas and an association of ideas. In this stage of the VE study, judgment is suspended, and the VE coordinator should make sure that team members are not criticized for openly expressing their thoughts. Keep in mind that often individuals are unfamiliar with such an open forum. This is especially true of team members without prior VE training. The VETC should be able to assess any reluctance on the part of team members to express their thoughts. Often the situation occurs where one individual will dominate the thought process even though his ideas may be good, he may be thwarting the thought process and the contributions of other team members. One way to bridge this gap is to have several types of creative sessions.

One creative session might be a group session where all the team members are encouraged to participate. The second creative session might be broken down into groups of two to three individuals that have established a rapport and a working relationship during the earlier stages of the project. The third part of the creative session would be the listing of individual ideas gathered during individual creative session. All the ideas are then pooled into one common list for further judgment. Checklist of ideas that were generated on other projects also may be a valuable asset to the VE team.

A technique used by Smith, Hinchman & Grylls in their workshop is to replace the traditional "No, it won't work" response with a "Yes, it will work if we do this". A more positive approach that generates positive results. The owner's participation in this part of the study is encouraged so he will be aware of the type of ideas generated.

After the VE team has completed the creative phase, each of the VE ideas is evaluated in terms of the advantages and the disadvantages. Impracti-

cal ideas are eliminated from the list. Other ideas are evaluated on a scale from one to ten, depending on the potential for cost savings, the potential for implementation and the credibility of the idea itself. The VE team will usually start developing other ideas from the creative idea list.

Keep in mind that during the development of value engineering ideas, the VE team should refrain from recommendations and changes that they would not make on their own designs. Each of the VE ideas that passes through the judgment phase and goes into development should have the support of the VE team and should have a strong practical application to the project. The VETC's Judgment Should be used in cases where there is vast disagreement on the rating scale by the team members. If the judgment phase and the rating of ideas is starting to take an inordinate amount of time, the democratic process might be employed. In this case, each of the VE team members is allowed to cast his vote in the idea rating. The votes are then averaged to give a weighted score. Remember that the main objective of the judgment phase is to thin out those ideas that are impractical and to concentrate on the best ideas for further development. If one team member feels strongly about the merits of an idea that others reject, let that person develop it. He may be viewing the idea from a different and possibly useful angle.

The team coordinator should take special care in assuring that each VE idea that proceeds to the development phase is thoroughly analysed to give a clear picture of the scope and purpose of the recommendation. All VE recommendations should include a description of the original design concept and the proposed design ; the reason for the recommendation ; advantages and disadvantages has a result of the revised design; sketches of the original design and the proposed alterations ; and a life cycle comparison of the original and proposed design . Before he will accept the idea and implement it into the design, the designer must be assured that the recommendations will benefit the project. He must be able to understand your rationale for the VE recommendation. A clear avenue for implementation of the recommendations will reduce the burden of acceptance.

The Final VE Report is prepared by the designer in concert with the owner. Each recommendation is evaluated and accepted or rejected. Often an idea will be rejected because a small portion is not acceptable. The reviewer is encouraged to seek out the usable parts of each idea. When ideas are rejected the reason for rejection should be stated. The final report should have a sum-

mary of accepted ideas and the resultant savings. The designer's response report addressing acceptance of each recommendation is referred to as the final report.

To maintain the integrity of the design schedule, the VE consultant is encouraged to complete the VE report as soon as possible after the workshop session.

It is up to the designer and the owner to select those ideas which they feel will benefit their project. All value engineering results are recommendations. Owners should also be aware that designer should be entitled to redesign costs where appropriate to implement value engineering ideas into the design. The redesign costs should be accounted for in the designer's evaluation of value recommendations.

After analyzing the preliminary value engineering report, the design engineer may have questions regarding certain VE recommendations. The VE coordinator should be available to answer these questions and to go over the designer's final VE report to ensure that no misunderstanding have evolved in the designer's or the owner's interpretation of the recommendations.

The last step in the VE process is the follow-up on the final results of the VE study. The follow-up may be equated to the post-audit. It also provides the VETC with valuable information on ways that he might improve future VE studies. We have also found great value looking at the project 2 or 3 years later to verify the life cycle cost and energy consumption.

4.9 COST MODELING

Cost is a major frame of reference used to assess the value of the things that we purchase. In construction projects, cost represents the amount of money expended for the construction of the facility. cost is the primary means used to compare value. This value might be in terms of quality, quantity, image or other criteria. In the comparison of alternatives cost adds the element of objectivity needed to analyse alternatives.

Reducing the cost of the building or facility and achieving the function at the same time is the goal of the value engineering study. Combining functions and eliminating unnecessary functions are two means of reducing cost. Keep in mind that function, reliability, operability or maintainability is not jeopardized in the effort to reduce cost.

Costs are used in the construction field from the very conceptual plan-

ning stages, through design and construction, and during the operation (useful life) of the facility. During the preliminary planning stages of the project, the degree of accuracy of costing is usually limited. The estimates made at this stage are usually conceptual in nature and are based on past trends and historical knowledge of similar projects. As the project develops, more and more detail is generated to enhance cost integrity. Costs can be applied to a given set of parameters established as a part of the design. As an example, during the preparation of schematic drawings, the various building system alternatives can be compared in arriving at a final solution.

The systems can be costed in terms of square footage, cubic footage, footprint area and other quantified amounts. The final estimate and the contractor's construction estimate are then based on definitive quantities and amounts, often described as unit price estimates.

The purpose of this chapter is not to outline procedures and processes for cost estimating. It is, however, intended to show the degree of accuracy required at various stages of design, and to how the cost estimates are transformed into cost models used to relate and compare alternatives.

A cost estimate and a cost model are communication tools. It is a tool used by the owner, the architect, engineer, contractor, operating personnel, bankers and consumers to arrive at a common language to assess value. A standard frame of reference that will give all parties a means to understand the exchange value received in return for investment.

COST CONSCIOUSNESS

The development of the tools and techniques of cost accounting and cost analysis from those referred for pure cost finding to the ones for cost control was necessitated by free competition and assessment of sellers market / buyers market. Cost reduction is another development to challenge standards or yardsticks against which performances are measured for cost control. Both cost control and cost reduction are considered today to be effective tools for minimizing costs and improving profitability and performances. But it is cost consciousness that lies at the, basic of any cost control or cost reduction measures. Unfortunately, the concept of cost consciousness is misunderstood and misused even by responsible people.

'cost consciousness' is not same as 'consciousness as to cost only', is the words of George Bernard Shaw, "The cynic is who knows the cost of everything and not the value of nothing" Ordinarily, cost consciousness sup-

posed to imply knowing only the cost of everything. This is only a partial approach, which confuse more than clarify, mislead more than direct our thought properly. In a typical cost reduction measure or economy drive, as it is called, it seems that greater attention is paid to stationery, telephone, conveyance, overtime, etc., which are more often C items and ignoring mostly the 'A' and 'B' items. According to the simple economic Law of Pareto, which perhaps a universal applicability, it is the 15% of the cause, that produces 85% of the effective conventional cost. Cost reduction measures pay attention to those 85% of the items or causes which effect the result hardly by 15%. This is nothing but demonstrative cost control; and incidentally, it claimed to be an atmosphere of cost consciousness. Most disappointing than this is the typical cash flow approach towards cost control, where by cost decisions are based only on the question affordability. Under this approach, costs can be incurred where the enterprise can afford them. When the situation is not favourable, say, when the concern can not afford the cost, discussion ensures about the so called cost consciousness. Such cash flow approach towards cost can not bring about true cost consciousness.

Cost consciousness should, therefore, be understood from a broader spectrum where cost decisions should not be a matter of affordability, but be considered as an investment proposition with the multiple objectives of growth, profit or surplus, etc. The emphasis should be shifted from mere consciousness to cost towards establishing a functional relationship between the cost proposed and the benefits expected. The approach should therefore, be not Cash Flow Analysis, but Cost Benefit Analysis. In the process, it may be found that a slight increase in cost in one area may result substantial cost savings or addition to net revenues in another area or for the enterprise as a whole. Profit or Surplus is the outcome of the interaction between the streams of costs and the stream of revenues. A clear understanding of this interaction is considered to be the real cost consciousness.

CONCEPTS OF COST CONTROL AND COST REDUCTION

Cost or expenses control and cost reduction are the crucial functional responsibilities of executives in all functional areas. If the expenses or costs increase disproportionately to the rate growth in income the profitability of the organization will keep coming down. Thus, it is important to keep the costs under continuous watch by the executives.

Costs reduction is intended to challenge the targets. Cost reduction is thus a more dynamic approach: standards tiniest all losses and diseconomies,

visible or invisible, direct or consequential. Conventionally, cost control is considered to be a continuous affair while cost reduction measures are undertaken in a while, followed by a well-knit programme. Cost reduction, no doubt, implies achievement of neat, significant and Permanent reduction in unit cost of goods or services without imparting their quality or use value, more often than not, cost control and cost reduction measures are both intermingled and dependent. They aim at the same objective, viz., reduced cost and consequently improved efficiency and productivity. Also, cost control techniques are often the media through which cost reduction is achieved.

This will enumerate first principles, steps, weapons and requirements of cost control and then the requirements and techniques of cost reduction.

1. Principles of Cost Control:

- Control on the spot where cost is incurred
- Controllability or uncontrollability of cost more often than not, dependent upon the particular situations obtaining and or the particular persons in charge.

Principle of balancing in a result oriented cost control (e.g., cost increase in one element might decrease overall cost and improve profitability) Scope for profit improvement even at the time of setting yardsticks or standards for control, to be explored.

2. Steps in Cost Control:

Definition of objectives and identification of areas

Development of yardsticks or standards for control of actual.

Ensuring in-built system of location of divergence and also its reasons.

Inclusion in the control scheme itself of a pattern of corrective action;

3. Weapons of Cost Control:

Control by the principle of exception (e.g., ABC analysis)

Control by comparison (against base, norm or past performing

Control through incentives-sharing of benefits emanating from persons effecting such benefits.

Two-fold control-consumption (for inputs) and lock-up (of capital)to get faster and better results.

4. Requirements of Cost Control: organization charts. Introduction of responsibility accounting.

~ Realistic standards and yardsticks (including their review as time elapses or situation change).

~ Greater participation and involvement in setting of standards or budgets.

~ Suitable reporting scheme.

~ Divergences reported, to be used for proper appraisal of results rather than faultfinding.

~Linking of incentives with cost control schemes.

5. Requirements of Cost reduction:

~ Management participation, support and motivation.

~ Planning-

(a) Accepting that possibility of cost reduction prevails; and (b) drawing up a programme for cost reduction.

~ Execution

(a) Obtaining co-operation from all concerned.

(b) Determining priorities in the various steps in the programme.

(c) Operation and procedural research to find the best way of executing the plan,

(d) Continuity of effort.

(e) Evaluation of the programme and result achieved.

6. Techniques of Cost Reduction:

~ Introduction and operation of profit centre and investment centre analysis.

~ Cost effectiveness analysis.

~ Cost benefit analysis.

~ Opportunity costing technique.

~ Value analysis/engineering (very useful especially in production- Man-machine balancing).

Non-traditional mode of budgeting expenses, e.g.

(a) Zero-base operational planning and budgeting which required justification of all activities and cost as if the operations were to be built up from ground or zero level; and

(b) Conversion of operating or functional budgets to more meaningful budgets, say, programme budgets, so that it is possible to relate spending for each programme to revenue from the programme to avoid or reduce spending on unremunerative programmes or activities.

Note: The various points included under the above items are only indicative and not exhaustive.

SOME IMPORTANT CONSIDERATIONS

There is always a tendency in Indian business houses today to confuse activity with productivity. Cost consciousness should be more productivity or result-oriented. If this can be ensured, it would go a long way towards inculcating real cost consciousness in an organization. Usually, the idea of cost consciousness and for that matter, cost control and cost reduction measures are actively thought of during critical periods, when an enterprise finds the going not so good just as in household front, everybody becomes conscious about that wastages and lavishness but only after retirement).

At all other times, when the enterprise is earning good profits and registering a satisfactory growth rate, the idea of cost consciousness is usually shelved. It is during such periods of good profits that cost decisions are based on affordability alone. There are instances also unplanned and indiscriminate spending during such periods. Quite a few of such expenditures become more or less recurring commitments or committed cost (e.g., unnecessary employments, especially at the higher level, are difficult to avoid, when not required. Most of the policy costs or imputed costs are also incurred during periods of good profits. **Examples** of such costs may be: offer of economic rehabilitation to a well-connected consultant, lavish expenditure on decorating the office and executive flats, and so on. While it is necessary that cost control and cost reduction measures should be undertaken as a continuing measure all the time, it is important that these are imperatives when the sailing is sooth. This is primarily because of the difficulty in taking judicious decisions about cost when situations are favourable and the company can afford higher costs because of good profits. Cost control and cost reduction should be considered as organizational tasks, not the sporadic ventures of a division or a group of people only. Otherwise, there is the possibility of sub-optimization from the overall organizational point of view, even though one division or section might achieve something significant by way of cost reduction. The concept of goal congruence is very important in this area as well. Cost reduction should be integrated

with the overall planning of an enterprise. Otherwise, there is the danger of lesser spending on a future due to an aggressive c reduction drive. There is a tendency to apply the axe heavily on the so-called unproductive expenditures (viz., planning, industrial engineering and design, market research, etc.), The company would run the risk of being out of market in the near future (since designs would change) or being ill-equipped to seize the future opportunities when they come. Such untoward situations can be avoided only by integrating cost reduction with strategic management. The consciousness as well as any cost control and cost reduction schemes could be linked up with the Management By Objectives (MBO) systems, since laying down objectives and evaluation of results in this area are quite feasible and can also be effective.

It is obvious that they would find it difficult to take the exhortation of cost reduction seriously. This is an important aspect to be taken into account in any efforts towards inculcating cost consciousness in an organization. Without proper motivation from the top management, more through practices than through precepts, an enduring cost consciousness cannot develop in an organization.

HOW TO REDUCE COST SO AS TO INCREASE PRODUTIVITY

This is basically a problem of de-activating each element of cost so as to bring about an all- round cost-slimness. To get these individual elements of cost neutralized to the desired level, is needed the base of a cost accounting system, on the degree of efficiency of which depends the expectancy of cost control. In other words, the same vigil as is necessary on a person prone to put on unnecessary fat is constantly needed in respect of each element of cost so as to save each one of them from accumulating excessive cost-fat. Here is an analysis of the elements involved in the composition of a costing system.

Reporting: Reporting is as much the life-blood of costing as it is of journalism. The effectiveness of both the journalistic reports and the cost reports depends not only on their quality, but on the speed with which they are produced and presented. Special reports (as distinct from routine reports) should be sent out as often, and with as much speed, as the situation warrants. Since speed is the essence. The aim is to pinpoint attention on activities likely to go off the track;

Cost Consciousness: They are often written in simple and comprehensible language, and also sometimes given only the quantitative variances as opposed to cost variances.

Budgets and standards: The spirit of cost consciousness is at its best in an organization in budgetary control and standard costing system has been implanted. The shops and departments are themselves formulators of their own budgets. These budgets, duly approved by the management in relation to a given volume of production, become the sanctions. And activity that is away from the sanction is required to be brought to the notice of the authority concerned, as to enable it to the immediate steps to bring it within bounds. Similarly, under the standard costing system, the variances between the actual and the standards duly analysed are also reported. Thus the budget, in conjunction with standard costing system, wherever in vogue, creates under the constant urge, and incentives offered to beat the budget go to reduce cost substantially. Where budgets and standard costing systems are in use, the principle of exception comes in handy while reporting cases of activities getting out of alignment.

Variety Reduction: Cost reduction can be achieved through variety reduction, if the number of varieties of a product is responsible for adding up disproportionately to its cost. On the contrary, cost reduction is sometimes possible by diversifying the activities of the industry.

Waste Reduction: Cost reports which indicate the percentage of yield afford great scope for improvement of yields, which in other words, means better utilization of raw materials and waste reduction.

Waste Utilization: As one thing leads to another, efforts to reduce waste might suggest alternate uses of waste or its disposal in a more advantageous manner.

Scrap: Similarly, segregation of scrap into the basic raw materials from which it is produced, would give better return when disposed off separately, rather than in one mixed lot.

Reworking: Sometimes, due to rigidity of inspection, some jobs, on which certain previous operations have already been performed, are required to be dumped on the scrap heap. Within certain limits, a few of such as could be salvaged, reworked upon and made fit to undergo further operations. Of a costing system can provide an analysis of the causes for such idleness, leaving it open to the authorities to take suitable action for bettering sales promotion for own products or undertaking outside jobs spare capacity.

Frequent changeovers: Frequent changeovers are symptomatic of bad planning inaccurate sales forecast, or faculty of storage accommodation. Here

in the batch quantity to manufacture normally in one run gets divided or split, bringing in its train an immediate drop efficiency. The effect of all short runs entailing setting and resetting and resetting of machines is for the cost of production which goes on swelling with every such changeover. In Overtimes To meet sudden rush of work, or to compensate for loss of production cause by major breakdowns, overtime working may be restored to. However, expect in an emergency overtime working is a costly luxury, and should be positively discouraged and/or curbed.

Stores Accounting: Many organizations insist on maintenance of detailed records of all items stores coming and going out. It should be examined whether and to what extent maintenance of detailed records of every low cost item is necessary, considering the cost of maintaining such records.

Accounting the above remarks hold good in respect of the accounting cost accounting service, which, it neither is nor realized by many, can be equally costly. The costing department should always be the first or apply the axe to its own department should always be the first to apply to axe to its own department's expenditures, wherever found to be heavy as compare to the results ensuring.

Inventory control is a safeguard against excessive locking of capital with the dangers of excessive cost of handling, spoilage, obsolescence, insurance, interest on borrowed capital, price decline, etc. the non-moving or slow moving items of stores require special study, to ascertain the alternate used to which they can be put, to relieve them from stock. This envisages audit of the purchasing department's policies and procedures, together with revision of maximum and minimum levels of stock keeping and of ordering point. To make or To buy whether or not a particular part should be bought or made depends on what the cost data indicate. If they show that it would be economical to buy from outside, that should be done so that the ultimate cost of production would be less to that the ultimate cost of production would be less to that extent.

Export Promotion in the wake of liberalization and subsequent overseas and thus not only earn the much needed foreign exchange, but also reduce their cost of production by employing relevant production methods.

Uniform Cost System:

The adoption of a uniform cost system.

Inter firm comparison of significant ratios and their analysis on an apple

to apple basis is thus rendered possible to highlight weakness and to take remedial action to improve ratio positions.

Single shift versus multiple shifts / new machines versus old peak loads arising out of sudden increases in demand for company's products, as well as of the policy of replacing old machine tools by the improved quality machine tools, capable of giving greater output is by side with expenditure on each for labour, super conversion, repairs, maintenance, power, depreciation, etc., for comparison.

Unnecessary paper work also adds to the cost in its own way. Besides, paper work, when continued longer than necessary creates problems. Further, unnecessary paper work is wasteful of time and energy which the shop supervisory staff should devour to production jobs.

Supervisory and indirect staff keeps on increasing. According to Parkinson's Law, the number of supervisory and indirect workers, if not kept under strict control will, in course of time, becomes bigger and bigger and like parasites and will cause a big drain on the resources of the industry.

Overheads: Unscientific fixation of overhead recovery rates may sometimes cause wide disparity in the cost of production of two units. To obviate such a situation, it is necessary that the basis for recovery of overheads is determined in advance in co-operation with the engineers and other technical heads.

Note: The various points included above are only indicative again and not exhaustive. There could be other areas too to be considered, depending on the situation and the alacrity and preparedness of the staff involved.

Savings

Saving is estimated by comparing cost of existing design process with that of the proposed design. A proper definition of cost is very important. There are various costs, viz. cost of production, cost of sales, cost of distribution etc., Similarly, there are direct costs, indirect costs, variable costs, overhead costs, fixed costs, etc. The two most important principles here are:

~ Cost must be relevant

~ Comparison must be realistic

Saving is possible in many ways, viz. labour, material, capital and / or overheads : 1. In many organizations, a 'norm' of comparison is laid down: Some firms may ignore part of the 'overhead' from these. Hence stipulation of conditions is a must for evaluating the savings. Costs must be defined along

with its conditions. We know that the variable cost per unit increases with increase in volume of production. Similarly, the cost of production remains constant for various production volumes within the installed capacity, when volume increases, total cost per unit reduces. Thus higher the volume lesser will be the production cost per unit. A clear understanding of cost aspects helps value engineers to compute saving.

Cost Analysis:

Basically, cost of production consists of the following elements namely, material, labour and other expenses. These are further sub-divided as follows:

Type of Cost	Condition	
Material	Direct	Indirect
Labour	Salaries	Wages
Other expenses	Direct	Indirect

Prime Cost

This consists of cost of materials, labour and any other direct expenses All these costs can be directly identified with the product.

Overheads: These consist of:

Indirect materials and other consumption items.

Indirect labour including that of the wages of directors, managers,

Supervisors, administrative staff etc.

Depreciation of capital employed, rent, electricity, postage, phone, etc

Techniques:

Various techniques are available to compute savings. These are ratio analysis, profitability analysis, break-even analysis, payback period, etc.

Similarly % of saving of material, labour or overhead can be calculated.

4.10 SUMMARY

A value engineering study involves participation between three main entities: the owner, the designer and the value engineering consultant. Unless the project is properly managed, its success will be hindered. Each participant has a role in the value engineering study.

A value engineer must approach the problem with an open mind. At the same time he should never take anything for granted. He should proceed in a systematic and orderly manner and develop a scientific approach in his analy-

sis. He should develop facts cause-effect relationships established by analysis of relevant data through scientific methods. Different methods are suggested to conduct value analysis by various authors.

The following phases are recommended to conduct value analysis - selection of product/activity, recording of relevant data, Examination of existing design, Development of new design/process, Installation of new design/process, maintaining new design/process. The study group must recommend one or more feasible alternatives. Usually if more than one alternative is recommended, the best-value alternative will be presented first in the final report. All the data, information, ideas, designs, cost alternatives, etc., relative to a VE study should be carefully recorded by the team recorder. Cost reduction is the crucial functional responsibilities of executives in all functional areas. If the expenses or costs increase disproportionately to the rate growth in income the profitability of the organization will keep coming down.

Check Your Progress

3. List the objectives of critical examination.
4. List the seven basic elements of VE methodology.
5. What are the benefits of inventory control in VE.

4.11 ANSWER TO CHECK YOUR PROGRESS

1. List the steps involved in carrying out the VE studies.
   - Identification of product for VE studies
   - Identification of desired quality level of product
   - Identification of systems, sub-systems and components and their inter and intra-relationships to perform the function
   - Identification of functions – primary, secondary and optional – of each sub-system and component
   - Assignment of weightings to functions in each of the sub-systems and components
   - Isolate function which are superfluous or unnecessary
   - Identify alternative means of achieving the function which give better value to the product
2. List the phases/steps that are recommended to conduct value analysis.
   - Selection of product/activity
   - Recording of relevant data
   - Examination of existing design/process.
   - Development of new design/process.
   - Installation of new design/process

NOTES

Maintaining new design/process

3. List the objectives of critical examination.
   - o Identifying unnecessary functions and eliminating them.
   - o Combining common functions between various elements into fewer ones to avoid duplication and additional cost.
   - o Re-arranging sequences of functional activities if that can eliminate additional stages in the design and Simplifying the design to reduce system and components without reducing quality.
   - o Identifying components and materials which can replace costly items used in the design.
4. List the seven basic elements of Value Engineering Methodology.

Product Selection , Determination of Function, Information Gathering, Development of Alternatives, Cost Analysis of Alternatives, Testing and verification by using the design or laboratory personnel, Proposal Submissions and Follow up for Implementation.

5. What are the benefits of inventory control?

Inventory control is a safeguard against excessive locking of capital with the dangers of excessive cost of handling, spoilage, obsolescence, insurance, interest on borrowed capital, price decline etc.

VALUE ENGINEERING TECHNIQUES

5.1 INTRODUCTION

The objective in product development is to get the best solutions to the problems involved it the shortest time and at the lowest cost. The best solutions will accomplish the function the customer needs and will provide the appearance that he wants. At the same time, they will do so at lowest manufacturing cost and with a minimum of manufacturing problems or quality difficulties.

The technique of utilizing and paying for vendor's skill and knowledge yields exceptionally high returns when effectively used, for the following reasons:

Large amounts of special knowledge exist in every field, and much of this knowledge is not possessed by people in other fields.

Only a relatively small amount of the total special knowledge bearing on any technology exists in anyone place at any one time.

Special machines, fixtures, tooling, and equipment exist in large numbers.

New developments known only to the engineers concerned with them are in progress in most good supplier's plants. They represent the best materials, processes, or parts to use "tomorrow" within the particular technology. They can be put to use only if the supplier is called into the job to which they are applicable. Suppliers want their new developments to follow actual needs in the market and they are usually searching for practical new ways of applying their technology .They benefit and the user benefits by working together.

It is important to note that we use the skills and know-how of others in the field of securing new performance is quite commonplace and quite fruitful. Such use is motivated by tests showing that suitable performance has not been secured. Faced with known unsuitable performance, the search for better answers is self-forcing, hi contrast, since value is net measured, simultaneous realization that better answers are required value wise is lacking; hence course of action often taken is to choose from the alternatives immediately at hand, and in reality, an integer of value loss results.

THE THREE SPRINGS

An electrical control used three springs:

One 2- inch long by 1/4 inch in diameter, plated steel, 23 cents;

One 1- inch long by 1/4 inch in diameter, plated steel, 11 cents

One 1/8 inch in diameter by 1- inch long, tension loops on ends, phosphor bronze, 17 cents; Total cost $17,000 per year.

A supplier who had an established reputation as a top specialist in good value springs as well as for good performance in springs was invited to look at the job. It was suggested to the sales manager of this specialist vendor that he take the product, the drawings, and such other operating and specification information as could be provided by the engineers, have his technical people suggest precisely what springs to use, and then provide suggested costs for them. His answer was surprising: 'I can't afford to do it."

When asked to explain his stand, he said experience had shown that when an engineer has had the drawing details and specifications of an exact spring made up, it is offensive to him to receive a quotation unless it is confined to precisely the geometry requested, and in the long run, the submittal of a quotation is injurious to the supplier who makes the suggestion. Only when the buyer who was taking part in the value audit of the product brought the sales manager into direct contact with the engineer and the engineer asked him to make a quotation did he consent to do so.

The springs were of such a standard nature that they could be made on completely standard spring machines and the supplier offered to submit five sets of samples for each of the first two springs and two or three sets for the third. He said he would provide twenty-five samples each and would furnish both a sheet of descriptive information telling exactly what each spring was and a sheet of test data telling precisely what each spring would do. This he did. The engineer was amazed and delighted. The cost for the various alternatives generally ran from one-fifth of the present cost up to the present cost.

After the test data and completion of some additional tests, springs were selected with the following costs:

$16,000 per year instead of $23,000 for the first group; $3,000 per year instead of $11,000 for the second group; $9,000 per year instead of $17,000 for the third group.

Besides, a modification of material on the third group provided improved throughout the life of the product. Utilizing available supplier skills and capabilities. The business of industrial suppliers is organized along one of two lines:

1. Make a product or provide a process which will accomplish the known and need function or group of functions, and then sell the product or process. Examples: turbine, motors, lathes, hammers, air- plane autopilots, printed circuits,
2. Develop a group of skills, a body of knowledge, and a family of facilities capable of accomplishing certain types of functions or certain types of work, then merchandise the capability to those who have corresponding needs .

This second type of business is most vital to our economy but much more difficult for the merchandise than a product or process. The value analysis technique that we are concerned with here ties in principally with the second type.

To locate the best suppliers of this second category requires active and effective search on the part of the user, especially since a vendor can not know what the needs are until he is located and told. The search is not simple. The first half-dozen or so vendors to whom the needs are communicated may not be the few having the special know-how needed, and thus the result become negative. Particularly high yields will be in proportion to the skill and effort, applied in using the technique. Again, a series of questions must be raised, such as:

What functions are required? What processes might contribute?

What vendors lead in each area?

When the answers to these questions are established, the definitions to take are as follows: Get in touch with the indicated vendors.

Describe the technical situation clearly to bring out what is really needed - the various functions; the limitations of size, weight, and dimension; the essentials of strength and appearance; etc.

State the economic situation clearly and fairly.

If there should be a prejudice by decision-making people against using any item, such as, stampings, castings, forgings, plastics, aluminium, or whatever, tell him just what the situation is. If he is competing against in-plant manufacture, tell him so; if the product, even after development, has a questionable market then can the supplier appraise the total situation and decide.

The next step should be to allow the vendor's technical staff test new answers, and to make a solid and new contribution. It is vital for the vendor to be given every opportunity to ask more questions about what is important and what is not important, and also that he be assured that his suggested solutions will be given attention by people who decided want the proposals to be satisfactory for the particular purpose.

Alternatives submitted should be reviewed objectively and the best- appearing value alternatives should be selected for possible further improvement. Objective information on shortcomings should be taken back to the submitter and help should be given him to overcome the problems if possible.

Usually, of course, only one supplier can win, i.e., earn the business. Several may work for it, one commonly earns it. That is the nature of doing business in the competitive system. The suppliers realize this,

before they start work, and they fully expect that the supplier with the best offers will get the order. All of these points up the great importance of completely advising them before they start work. They must be made acquainted with all of the "rules of the game" before decide to go into it.

After a vendor has produced the best answer-one substantially better than the one used prior is work on the project -he has earned the business and must be given the opportunity to retain a reasonable length of time to fairly repay him for his development work.

It is indeed wrong, and cannot be tolerated, to draw up his ideas and send them out to other vendors for quotation;

Allow factory personnel to decide that they can make it that way in the plant. Such actions will cause the best vendors to stop wasting their good technical talent on the products or processes of the manufacturer involved. Besides, they will thereafter turn to assisting his competitors instead of continuing to help him. Paying for his work by placing orders with him if he contributed is not only the ethical thing to do but is also, selfishly speaking, the only course of long-range self- interest.

EXAMPLE : Handle for machine tool adjustments

An operator uses this lever to make necessary adjustments by tuning it clockwise. Screws in the ends have opposite threads, one right-hand and the other left-hand; rotation in one direction lengthens the handle and rotation in the other direction shortens it. What functional properties are required?

A rigid handle to be axially expandable and contractible. A handle capable of 300 pounds pressure

A surface on the handle for hand grip

What process might contribute?

Machine from bar; knurl and tap

Techniques of Value Analysis and Engineering

Machine from tubing; knurl, plug ends, and tap

Make from aluminium impact extrusions; plug open end and tap both ends Make from aluminium extruding tubing; plug ends and tap

Make from sheet metal, rolled and crimped; plug ends and tap. Make from suitable plastic

What vendors lead in each area? Select one or two good vendors in each of the indicated areas, the number depending upon the importance and amount of business involved. Follow through the remaining steps of the technique, as outlined above, with each of them. Help each to apply expert knowledge and facilities.

The results of the technique will now be apparent. The special function required in the product will be reviewed in the light of the most advanced skills, techniques, and facilities within several technologies. All resultant alternatives will be unveiled before the decision maker to enable him to promptly increase the value of his product.

Utilize Specialty Processes

Generally speaking, all processes serve for one of two purposes.

1. They accomplish functions that can be performed in no other way.
2. They accomplish performed functions equally well but at much lower cost.

The second group takes in an extremely large number of value-oriented works.

All processes might further be divided into two classes.

1. Processes that are known and are reasonably understood.

2. Processes that are not known to the decision makers but which would be applicable and would accomplish the desired ends at very much lower cost

Again, it is this second class that we shall deal with. Let us first see how processes which will accomplish functions reliably at very much lower cost but are not known to the decision makers at particular time may be brought into view and how their benefits may be utilized in value work.

Of course, what is a special process today commonly becomes the standard process of or row. Therefore, a line between the special and the standard process does not really exist, the references being a blending of shades of grey. For practical purposes in securing important benefits the technique in question, the best definition seems to be that a specialty process is an applicable process which would reliably accomplish the needed function for significantly lower cost which either exists or could, and would, be developed by some one who leads in the technology involved if he understood the need for it.

Part costing 11 cents each, the process of roll threading at a cost of 2 cents would be a specialty process.

Similarly, the hollow-forging method would be a specialty process engineering and manufacturing men who did not know that hollow forgings 2 feet in diameter and

2-feet long could be made with very high grade properties for $3,000 each after finishing machining take the place of a similar part made from solid material at a cost of $6,000 each after machining.

The capabilities of specialty processes to accomplish functions per dollar of expenditure extend beyond what is normally recognized. Such recognition by professional people engaged in technical value- oriented work normally lags about three years behind capabilities.

A good estimate seems to be that the recognition of normal decision-governing design and manufacturing engineers lags about five years behind capabilities. It is the purpose of the technique under discussion to eliminate an important part of this five-year lag.

Most specialty processes go hand in hand with the never-ending development of special tools. For example, claw hammer was developed to facilitate nail-pulling. Developments have taken place in hammers for metalworking and other fields. Probably engineers know all the various stages of develop-

ment of the simple hammer, each for the purpose of improving a building or manufacturing operation of a specific type, and generally for main purpose of improving value.

For example, the casting process starts with the basic sand casting and spreads in almost hundreds of different types of "casting processes. Some of these are uniquely appropriate achieving a certain function by the use of some particular metal or temperature range; others fit the attainment of specified tolerance, lack of porosity, desired appearance or surface conditions etc. A group of typical casting processes are:

Sand casting Precision casting Shell moulding Permanent moulding

5.2 CASE STUDY 1 -MOUNTING HOLES FOR PERFORATED SHEET

For an appliance, a 1/32-inch-thick galvanized-steel sheet, 1 1/2 feet perform its function, it was necessary to punch 10,000 holes and each punching cost 68 cents.

This supplier of continuous perforating equipment showed that the material could be continuously perforated in the long uncut strip and that some of the holes could then be used for mounting.

Investigation showed that the ends were bracketed and that cutting through the perforated area would detract from neither usefulness nor appearance. The change was made with a reduction of 59 cents per sheet in punching cost.

Application of the technique of utilizing specialty processes involves three steps.

Recognize that processes which would accomplish the desired functions for very much lower cost (a) may exist and not be known, (b) are being developed, or (c) would be developed if competent men in the technology knew of the need.

Put in motion actions which will increase the likelihood that specialty competence knows about, and becomes interested in, the needed functions.

Assign time and effort to stay with each item until the minor problems, minor objections, and minor misunderstandings which always arise in any new approach have been illuminated with useful and factual information. The aim here is to ensure that the results to be expected from the status of science at the particular time will indeed be developed and made applicable to the par-

ticular project. It should be recognized that such listings may lag from three to five years behind actual industrial capabilities. Also, available tables are useful guides but do not supplement the further step of making direct contact with individuals who lead in any technology.

EXAMPLE 1: The undercut screw was being used in quantities of 20,000 per year. It was made on a screw machine from steel bar, was 2 inches long, and was undercut. A study of the functions revealed that the screw was a suitable means of accomplishing the functions, provided the undercut could be produced more economically.

A specialty manufacturer who produced cold-headed and roll- threaded screws was among the ones contacted and informed of the need. He took the following approach: "I believe I can adapt the roll-threading process to remove the metal from the under- cut portion. I will try to first roll a thread and then roll another thread so displaced as to remove the metal left by the first process. If necessary, I will complete the operation by rolling enough successive threads".

He became very much interested in adapting his process to the need, so he tried it and it worked. The cost with the use of this specialty process became 17 cents.

EXAMPLE 2: The small bracket was used in large quantities and a small spring assembly in an appliance. It was made of steel on well mechanized equipment. Nevertheless, the drilling and tapping of two small holes brought its cost to $13000.

The functional study showed that this was a simple and practical way of accomplishing function, provided the cost of tapping the holes could be lowered substantially.

Search for a specialty process brought the cost to one forth. A supplier recognized this type of part being sufficiently common in industry for him to build a good business by creating special equipment around it. In his special tooling, he bent the material and drilled and tapped the holes all in a continuous process. As a result, he quoted a price of $3 per thousand for the identical product made from the identical material.

EXAMPLE 3: A moulded-rubber gasket a few inches in diameter and costing 11 cents, used in large quantities. The functional study brought forth a number of alternatives accomplishing the function. Most of the alternatives involved the use of rubber material but not necessarily a moulded gasket of the precise type used.

The search for an applicable specialty process identified a manufacturer whose equipment applied rubber directly to the needed parts in plastic form. The desired result was obtained placing a small machine in the production line and applying the plastic rubber directly to the part, an operation that required but a few seconds. The total cost for a functional product of high quality as the former product became 9 cents instead of 11 cents.

All cases of the profitable use of this technique to accomplish the following in common:

1. No applicable specialty process is known.
2. The function needed in the product is brought clearly into view for study.

EXAMPLE 4. A specialty product

A small aluminum knob and pointer were machined for use on air borne electro equipment. The cost was $2.25 per knob. The function was to provide for manual adjustment small potentiometer. Available specialty products in the form of suitable plastics with metal insert would accomplish the total function with the same reliability for 25 cents.

Once this information has been secured and it is known that the 25 cent knob is available and will accomplish the function with the same reliability, its direct substitution is a straightforward matter.

EXAMPLE 5: A standard process detail

A small spring was required to have hooks at each end. One of these hooks, rather than being of the usual turn form, was of an elongated shape. The cost was 9 cents. A study of the cost showed that, by changing from the standard process of providing a spring end hook and going to the special process necessary to produce the elongated end hook, the cost of the spring was increased from 3 cents to 9 cents.

With this information uncovered, a study of the application was made, and it was found that, with a minor change in the location of the hole of the mating part, the standard spring-end process could be used. By this change, the cost of the spring dropped to one-third of its original cost.

EXAMPLE 6: Do not use inapplicable standard products.

One million small eyelets were used in an electronic device. These eyelets were made of brass and cost $1.75 per thousand. Examination of the required functions showed that, while the eyelet accomplished the functions

reliably, all of the features of the eyelet were not needed for this application. Discussions with eyelet manufacturers revealed that, with a quantity of 1 million, the eyelet machines could be adjusted and special runs made to provide special functional eyelets for the purpose in question at 80 cents per thousand.

From hundreds of examples in which standards have been reviewed some used and some rejected with respect to a few common criteria stand out for standard materials, processes, products, parts of materials, parts of processes, parts of products, etc. Knowledge of standards of all types is the basic ingredient around which all deviations for the benefit of value improvement must be organized.

If cost and applicability data have not been developed with regard to the function required, the chances that the needed functions are being accomplished at near their lowest practicable cost are decreased considerably.

5.3 CASE STUDY2- STANDARDIZE THE PACKING

Although a range of sizes, styling, and types of electric clocks were being made to fit into decor of each room of a house, it was recognized that there existed a substantial market for an alarm clock. Therefore, one clock was designed and marketed which included a minimum of cost producing aesthetic factors and features. It was a very successful product and sold in large numbers. During a value audit on the clock, one of the expense items investigated was the packaging. The competence which could be found for this type of package was invited into the job. One of the packaging specialists was very enthusiastic and felt that he could provide a package which adds marketing benefits to protect the clock even better and to cost less.

Two weeks passed and nothing more was heard from him. When contacted by telephone replied, “We stopped our study of that.” When asked why, he said that in his investigation he confronted by a man who had the assignment of promoting standardization. This individual held the packages now used on the whole line were a standardized family of packages-all based on same philosophy and with each deviating only as much as necessary to fit the individual criteria. Therefore, to develop an alternative would be a waste of time.

Nevertheless, the vendor was encouraged to develop the alternative in line with his original plan, and this was done. The use of the suggested new package for this one extremely high volume clock would reduce costs $150,000 per year. With this full blown value alternative in hand, the decision was

promptly made to delete the particular item from the standardized group in order to decrease costs and improve the package. Over standardization does not bring the best value.

He knows that he cannot get reasonable value in exchange for his resources unless he has value alternatives clearly established and uses corresponding information as criteria in decision making.

Before he spends his money, he will have clearly in view the relative use values, the relative aesthetic values, and their relative costs.

The reader may recall for a moment that, in achieving value, it is vital to do what makes the best sense. Any deviation from the answers that make the best sense results in either diminished performance or decreased value. Diminished performance can usually be identified promptly by tests. Decreased value, on the other hand, often remains to be identified by buying resistance. Even then, cause and effect are so separated that the particular answers which do not make good sense are not necessarily in clear view.

Both motivation and direction are provided by the effective use of the technique with which we are here concerned. Unless the answers by design engineering, manufacturing engineering, purchasing, and management in all areas involved in decision making can affirmatively meet the test, "If it were my money, would I spend it this way?" It should be seriously questioned that a good degree of value exists. The application and effect of this technique will become more understandable as it is seen in a number of typical examples.

EXAMPLE 1: A 3-inch diameter hand wheel on a small valve cost $3. Its function was to provide manual opening and closing of the valve. "If it were my money, would I spend $3 for the valve handle?" With this motivation, manufacturers who produced handles for valves were sought out. It was found that hand wheels of the same size for the same function, specially cast and machined for this application and made of the same material, could be provided for 60 cents each.

EXAMPLE 2: A moderate quantity of heavy solid-steel bolts, approximately 8 inches long with hexagonal heads 3 inches across flats and with a bolt section 2 inches in diameter, were needed. Round bar was purchased and the bolts were machined completely from it. The cost was $11 each.

Utilize and pay vendor's skills and knowledge. Utilize specialty processes. Utilize applicable standards. Use the criterion "Would I spend my money this way?"

EXAMPLE 1

Basic step job plan for Accelerator

The item is a 1.5 -inch diameter V-belt pulley for light duty on 4-horse power motor shaft.

It is planned to machine it from a 2-inch steel bar. Its planned cost is 60 cents. Specifications and drawings are accumulated. There are no close tolerances. Quantity will be 60,000 per year. Comparison with available pulleys which are similar but not precisely usable shows the standard to cost 10 cents.

An addition of 5 cents to add special requirements gives a tentative value for the function of 15 cents.

Tools most likely to produce the best solution are chosen.

Searches are made for different ways of doing it; for the manufacturing; for different materials, processes, and ideas;

Basic step job plan

Search for standards. Get in touch with specialists using specialty processes, show them the need, and interest them in the job.

Judgment indicates that two alternatives may justify intensified study. They are:

Modify vendor's standard.

Make as die casting in plant

Get in touch with proper vendors and arrange for information to be developed on the basis of a standard product suitably modified. Arrange for manufacturing and cost alternatives to be developed for in-plant manufacture.

Follow each of these alternatives, providing more information as needed and making more suggestions to help each succeed.

Prepare a status summary and conclusion sheet showing original intended cost of 60 cents with two alternatives:

Modified standard, 25 cents.

In-plant manufacture including tool liquidation, 23 cents.

As experience is gained, the steps become automatic, the selection omitting any significant steps or techniques, efficiency and effectiveness are blend into and through one another.

EXAMPLE 2:

The purpose of the study is to hold an electric motor on high-volume equipment and space a dust cover over it. It offers no appearance or aesthetic values to the customer. It is a used part. It costs 15 cents.

Quantities are 400,000 per year. The material is steel. There are no close tolerances. It's made on automatic equipment from standard steel rod. There are no quality problems. Its cost in labour, material, and overhead is 15 cents.

Drawings, planning cards, and samples, including an assembled and a disassembled sample of the product using the stud, are at hand. With the function clearly established as a holding function and a spacing function, comparisons are now made to place the value on each function. The cost of the holding function can be compared with that of a screw of similar dimension, which would be about 112 cents. The spacing function can be compared with a piece of tubing cut to proper length or a piece of flat metal rolled to form a spacer. In either case, the cost would be in the neighbourhood of 112 cent. Therefore, by comparison, the sum of the combined functions is evaluated at 2 cents.

These means are listed. Although several useful alternatives were identified, only one will be pursued through the remaining steps of evaluation.

Discuss the requirements with industry specialists, search for vendors' functional products, provide information on the functional need to vendors' technical people, provide information to suppliers having specialty processes which might be applicable, and search for standard products.

A supplier of cold, and roll-thread parts proposed a suitable screw at 172 cents.

A supplier of rolled spacers, which were a specialty product for him, proposed a suitable cylindrical spacer at slightly under 11 cent. This spacer and the roll-thread screw assembled together ready for use would be equivalent part costing 2 cents.

A suitable program was set up with the supplier of the

special screw so that samples were made and provided. On a quantity of these were mounted the rolled spacer from the specialty supplier. With quotations and samples at hand, the move was made to the next step.

Cost sheet revealed: Initial cost, 15 cents

Cost as changed, 2 cents

As may be quite obvious, it is seldom known in advance what technique

or results sought. Nevertheless, it will be illustrated by the additional examples with particular technique is often the key to the identification of large amounts. Yearly reduction in cost, $52,000

samples dealing with "Generality" Stoppers of unnecessary cost, these examples, the complete framework is omitted and only the parts of evaluation being studied are detailed.

EXAMPLE 1: Electrical terminal.

The function was to facilitate reliable connection of wire to electrical equipment. The terminal was made from copper strip by fully automatic processes on a four-slide machine. It used very large quantities. Effective value work on this item was retarded by a prevailing belief that "made automatically from sheet stock on high speed four-slide machines, it simply cannot be beat." Being a simple part it was made from the lowest cost form of its base material, copper strip. The controlling generalizing was that all experience of the past had proved this to be by far the most economical, simplest, most straight, forward way to make that type of part.

In the light of accelerator, it was apparent that even effective attempts at good-grade value work were being stopped by this generality. Therefore it was decided to temporarily disregard the belief and to develop objective data.

Using accelerator it was found that a specialty supplier had so improved his processes that he could produce copper tubing for almost the cost of producing copper sheet and strip. He also possessed very ingenious machines for making a variety of fabrications from this tubing. Further, his organization possessed a high degree of skill in adapting its special equipment to the special needs of its customers.

Spring-locating parts at one-tenth of former cost.

This attack brought forth an interchangeable part at sufficiently lower cost, with the result that the function was secured. The professional user of value analysis techniques will soon learn to recognize situations in anyone of the techniques does not fit and also that each accelerator, in its own right, becomes the real cause of accomplishment for those particular types of products and situations for which it is provided.

EXAMPLE 2: A part machined from steel bar served the function of locating the ends of two compression springs. Quantities were 5,000 each year. It was produced, however, in conjunction with some other similar machine

work. In the information phase, when costs were requested, the answer was that costs were "unavailable." It was thought that because the part was being made in conjunction with a number of other things on equipment which might otherwise stand idle and by workmen during setup time amid in odd periods between other jobs, it really had very little cost and that it would be meaningless to develop its own specific cost.

Turning to accelerator 2, which emphasizes the importance of obtaining and understanding costs, it was decided to determine the cost. With this decision and the action that followed, the cost figure of $1.08 a piece became available. The effective use of technique 2 made it possible to follow up with other techniques. The result was that a tool costing $1,100 was made, and an interchangeable part accomplishing the total function was then produced as a stamping for a total cost of 8 cents each.

It was only after emphasis was put on the proper use of technique 2 that the project opened up so that the remaining techniques could be used with a resultant return of $5,000 per year for an expenditure of $1,100.

A technique which often facilitates initiation of effective work is accelerator 3, "use information from only the best sources." Not un- commonly it happens that a source which may not be best for exactly the specific question proves best for a nearly related item or process.

EXAMPLE 3: Weld supports for 1-inch thick were cut from steel bar. The quality was 3,000 per year and the cost $1.41 each. The irregular shape and the relatively small quantity combined to necessitate considerable work on each. The part was used as a "weld segment" to fit into an opening in large equipment where it was welded in place as a part of a homogeneous mass.

The manager of tool design said that the part was costly to make by individual processes.

The idea came from a highly skilled man in the field of dies, die construction, and costs. It was difficult not to recognize him as the best authority on the question. The fact however, that his experience was generally with large quantities, and he did not have up-to-date knowledge of small-lot stamping technology.

When technique 3 brought this clearly into focus, an estimate was requested from a supplier of small-lot stampings. His quotation was $75 for tools and thereafter 39 cents each for parts. This, then, was case in which application of technique 3 led to a follow-through with succeeding technique

specifically technique 11. The investment of $75 brought an annual return of $3,000.

Effect on Other Work in the Business

A number of very vital interrelationships come into play in the effective use of value analysis techniques. Some of the most important of these are the relationship of value analysis to:

Accounting, appearance, design, cost reduction, engineering manufacturing, management purchasing, quality control, sales.

In the simplest language, the objective of value analysis and value engineering is to develop practical value alternatives to the end that all decision making will achieve an improved degree value in the final product or process.

Accounting

In the same simple terms-perhaps too simple for the accountant-the principal objectives of accounting activity are twofold.

1. Accumulate suitable after-the-fact figures so that period-end profit and loss accounting will be proper both for tax purposes and for business owner's purposes.

2. Suitably apportion costs and incomes are to be considered.

Systems can be developed to accomplish particular purposes. The serious problem, however, is that accounting systems often are used either as they are or in some amended form for other than the originally intended purposes and then are not as elective. As in the physical sciences, where men often endeavour to accomplish several purposes with same product and seldom accomplish divergent ones efficiently, so often is with accounting systems.

Although, as the accounting manager stated, accounting systems can probably be developed to accomplish almost any purpose, there is quite naturally and properly a great reluctance on part of the management to provide more than one basic system. Since tax and earnings accounting considered efficiently absolutely vital, compromises are usually made and inefficiency is allowed in the part covers useful and meaningful cost data for making before-the-fact decision.

While at first glance it would seem simple to determine how the business would be affected by making a part, this can not be done by merely determining the material used, the labour required the indirect expenses in the form of maintenance and liquidation of machines and equipment employed,

and the amount of consumed supplies, Buildings are involved which might, or might not exist regardless of the decision on a particular item, The entire supervisory and management staff the organization will probably exist regardless of the decision on the item, and the same, amount of space may be required regardless of the decision; likewise, the same amount of maintenance may be required. The question of determining precisely how the business will be affected if a particular decision is made to buy rather than to make is a most difficult one.

Often, with traditional systems of accounting, it is more straightforward to determine how tilt business will be affected by a change from buy to make if the change is comprehensive enough so that new buildings and new machines will be required. In this case, definite costs can be assigned al an increase to be computed in the decision-making formula. The sticky problem results when serious consideration is given to taking the decision in the opposite direction, i.e., from make to buy, because now many facilities already on hand and already being paid for in various accounts may not be needed.

A further reason for the need of particularly objective and meaningful comparative cost in this particular Connection is that make-or-buy decisions lie in the emotional area. A strong emotional pull toward decisions to "do it ourselves" usually exists. Often, this pull is so strong that neither the accounting specialist nor anyone else is requested to develop really meaningful alternatives which could lead to decisions contrary to the do-it-ourselves practice.

Finally, it should also be noted that the techniques of value analysis , apply to any action which costs money. Each activity of the accounting unit can be analyzed by the use of these techniques to determine precisely what function is accomplished by each act, by each piece of paper, by each file, by each person each minute of the day. Such evaluation by accounting people, who have first learned to use the value analysis techniques and then applied them to their accounting practice, has brought important yields.

Appearance Design

Those not engaged in value work often believe that decisions prompted by value analysis techniques will tend to decrease the appearance and attractiveness of a product. The latter class is comprised mainly of features of appearance and convenience. More often n not, the application of value analysis techniques results in an improvement in the appearance of product by opening up opportunity for effective work in the appearance-design activity.

One of the phases of the study of a product consists in determining precisely what, from the point of appropriate volume of sales at appropriate prices, constitutes the major areas of opportunity .These opportunities may fall in one or more of three categories :

Improved performance Improved appearance and! or features Lower cost

With the factors of appropriate performance and appropriate cost under control, attention is sharply focused in the areas of improved appearance and features in order to build up the appropriate sales volume.

Value analysis studies have shown that great opportunity exists in the appearance-design area, technical people, however, who are expert in development of performance, often do not realize the magnitude of the contribution which can be made by those especially skilled and trained in appearance design, hi many cases, they make decisions affecting the appearance as best they can." This usually results in added cost and only .a moderate degree of appearance improvement. Because of such experience, there is a rather widespread belief among technical people that improved appearance requires increased cost. This is seldom the case.

Being specifically oriented toward identifying the problem and developing better solutions to the value pr analysis techniques promote the use of specialized skills and knowledge in all fields, including that of appearance design: With appearance-design aptitude brought to bear on design f problems very much better appearance at substantially lower cost usually results.

The work is taken in absence of temporary performance problems, suitable performance of the product is the result of long-term and regular activities.

As for cost, the situation is almost directly the opposite. It is every one's job. How a good degree of value is obtained is not too well known, nor is the degree of value obtained readily measurable. Each person involved does as well as he knows how. The normal measurement of the suitability of value work is based on an appraisal or a guess how well it is done as compared with how competition does it.

Since performance work is basically "right-hand" work and value work is traditionally "left- hand" work, it is normal that costs often become too high. Short-range activities of a fire-fighting nature must be established and must be given enough emphasis to prevent results that are intolerable.

Often, in a particular business, the extent of this problem can be predicted, so it is planned well in advance to impose, by a number of expediencies, a certain amount of cost-reduction effort, together with the resultant measurable reports throughout each regular period of a year.

The work involved competes with the regular work of most technical men who believe their principal job is one of accomplishing other objectives-usually performance objectives, new-product objectives, or similar ends. Quite commonly, the manager or boss is more oriented toward, and more comfortable with, performance work, and so his best supervising effort goes in the direction of helping and measuring his subordinates on the performance parts of their jobs. To him, cost- reduction work then becomes an added or "thrust-in" burden which he must, to some extent, do something about.

In these circumstances, a certain amount of pressure may be necessary to compete with the motivation for the regular phases of his job, and he is often told that it is intended that he shall spend part of his time, perhaps one-half day a week, on the cost-reduction activity. In order to strengthen the pressure which will cause him to do this, he is given a budget of savings which he is expected to accomplish in a certain period.

Cost-reduction work, as a rule, is after-the-fact work. The tooling has been provided and the product has been standardized; changes spell deviation, hi many cases, replacement parts must be continuously stocked, and when changes are made, other items must be added to the catalogue. Likewise, drawings must be changed. Indeed, these and many other deterrents to good cost-reduction work often diminish results of the activity.

Nonetheless, what is known as cost, reduction is a vital activity. As most, businesses are organized, they could not long endure without it. A first step, when instituting a value analysis program, is to make sure that those who are working on cost reduction continue to do at. least as much of it. as they have been doing. A great deal of effective cost-reduction activity will be necessary until a planned and integrated activity, professional skills, techniques, and knowledge are provided to the business so that value work can be taken in stride, the same as performance-oriented work is.

As a business begins to apply value analysis techniques to cost reduction, two changes will be observed. The results per man-hour of cost-reduction work will be greatly increased.

More satisfaction will be derived from the work because it will be seen to be effectively done with the achievement of a larger yield.

Cost Reduction versus Value Analysis

In contrast, value analysis is a long-range planned activity. It has set objectives, and it operates to always keep the costs right.

Similarly, just as long-range integrated performance work uses good tools, long-range integrated value work uses good tools to accomplish the set objectives.

Suitable value work is done in the product-conception stage, in the engineering-design stage, in the manufacturing-engineering stage, in the purchasing stage, and in the production stage.

By doing this work on a planned basis as the product "grows" and is developed, it becomes practicable to take many actions not possible in after-the-fact cost-reduction work, which is not a part of the normal pattern and which is hampered by problems of existing tooling, standardization, servicing, replacement, etc.

The reader must not, however, overlook the fact that the value analysis techniques are often also used on products in the after-the-fact stage, especially when the particular industry has progressed to the point where substantial redesign is imminent or when a competitive degree of value work has not been during the earlier product stages.

5.4 CASE STUDY3 - CAN WE SCRAP THE SCRAP?

In order to secure advantageous operating characteristics, it was necessary to provide a Silicon-steel transformer core of a specific configuration with relation to the coils which went on it the steel laminations were stamped to make this core, 42 per cent of the steel became scrap with remaining 58 per cent was used in the product. It appeared that, without sacrificing efficiency or operating characteristics, this was the way to do it.

A value consultant brought into contact with the job went to the silicon-steel specialist and so to the transformer specialist in a large research organization and confronted them with the problem. It just didn't seem right to him to live with the enormous amount of unworking cost involved in throwing away 42 per cent of the silicon steel. The silicon-steel specialist brought forth change which resulted in reducing the scrap from 42 percent to 25 percent by working out a stamping pattern. Two months later, after careful study and test, change which eliminated 5 cents a piece of the cost on 3 million transformers per year.

Then two interesting things occurred. The engineers were startled and intrigued that could be done, and both the transformer-circuit specialist and the silicon-steel specialist become intrigued by the problem. In about a year, another suggested improvement was made and test this involved changes both in the silicon-steel core and in the coils. Improved performance found to be provided without adding to the coil cost, and the silicon-steel loss was reduced to 5 percent.

In conclusion, the relationship of value analysis to engineering is one of generating great expanded information for the use of engineers and of identifying value alternatives for the engineer inclusion in his decision making. It is little wonder that the first vice-president of a well-known company to examine the operation of these techniques stated, "Value analysis is the belt method yet found to help engineers remove unnecessary costs from their products.

Manufacturing

Basically, the job of manufacturing is to use machines, processes, and people to change the form of material to conform to the designs of engineers.

The basic function of value analysis is to identify each element of function provided by each element of cost. Accordingly, the consultation provided by the value analyst to manufacturing will start always with a clear identification of the contribution to function furnished by each activity in manufacturing which adds cost. Creative study of the increments of function and of the increment of cost brings expanded information into the decision-making area and makes practicable a still further elimination of unnecessary cost.

For example, more information is provided by observations of rather difficult or time- consuming operations throughout manufacturing.

What contribution is made by the hardened steel?

What contribution is made by having holes slightly different instead

contribution is made by heat-treatment between operations?

What contribution is made by a tapered instead of a straight

What contribution is made by an operation that is

5.5 CASE STUDY4 - DID THE VENDOR CONTRIBUTE?

No operation should be performed by manufacturing people unless it contributes to the enterprise; infact, if many are performed which do not contribute, the vitality of the business is sapped. This case reports one of a study to determine the realities of manufacturing contribution,

one phase of value work on an assembly of a few hundred parts, quotations were obtained from appropriate vendors on machine parts which were actually being made in the plant. The quotations showed that, on a considerable number of the specialized parts, vendors' prices were lower than that of in-plant manufacturing cost, which consisted of labour, material, and overhead.

In this particular plant, it was the custom for the manager of manufacturing engineering to make-or-buy decision. He was considerably challenged by these lower competitive costs and arranged for a study of his own manufacturing operations on the items in question. In all but 12 cases, he was able to lower his costs comparably, and hence he allowed only the one par to be placed with a supplier. This was protested by the purchasing people who had been instrumental in helping select the vendors who provided the Lot lower quotations. As a result, the case was resolved in the higher manager's office. There after the facts were developed, the question was asked: What is the right action for us to take in cases of this type? It was quickly decided and accepted that the right action was, whenever suppliers had made contributions, to compensate the same in some suitable form.

The manufacturing engineer, however, felt that the suppliers had not contributed. "They did show us how to speed up our machines, how to use different types of cutting tools, how to p some of the parts more effectively. All of this we did ourselves."

The manager's response was, "Whenever anyone comes here and takes any action that calls us to eliminate substantial amounts of unnecessary costs from our products, he has maximum contribution regardless of all other circumstances." Again he raised a question: What is appropriate action to take in this case?

Good value work will help rid manufacturing areas of "busy work" which does not contribute, so that their efforts may be used on operations which make important contributions to the business,

Often manufacturing work proceeds along rather habitual lines involving the particular products being made on orders placed with the factory for quantities according to specific schedules. More complete information on expected quantity requirements, inventory-carrying costs, types of tooling for the resultant volume, and applicable specialized vendor knowledge often allows the manufacturing decision makers to eliminate important amounts of unnecessary cost.

Whenever a change is to be made, there is much work to be done in connection with obtaining the new and complete information, analyzing and evaluating it, and persuading those involved that the path to better value lies in a different direction, hi all these activities, the value analysis tools and special knowledge are very helpful to manufacturing.

Misunderstanding is often eliminated by the application of value analysis tools. Too often costly specifications are continued, and in effect, needless and costly operations are performed which do not, if the whole story were known, add in the slightest to value. In one instance a stamped steel bracket was carefully "sized" in an expensive operation so that it would fit perfectly into a mating part. Study to ascertain precisely the value that came from the mating operation showed that a lead mallet was always used at assembly and so, of course, the sizing operation made no contribution whatsoever to value.

The process of associating precisely the contribution to function of each addition to cost identifies the area in which the relationship of value analysis to manufacturing allows manufacturing men to make different decisions that help solve their problems, speed production along, prevent quality problems, and lower costs.

Basically, the objectives of management with relation to the organization, including facilities, and to make the proper decision profitable, all the tragedies of bankruptcy will soon occur.

The method is to use the resources of capital, men, products (or services) as skillfully as competitors do.

5.7 CASE STUDY-6 THE CONTACTS THAT WERE LOST

Large benefits to management result from the new information which they can now have as a result of knowing the value of the various functions from the products they manufacture. Often normally undiscovered opportunities to increase these values will result. The design of new products or in major redesigns, accumulated experience is studied, new information believed to be applicable is searched, and models are prepared for test. In the case of electrical equipment, certain types are also sent to the Underwriters' Laboratories for its inspection and test. The value audit of a product which had been in production two years indicated that it contained considerable "waste," that is, cost which .made no contribution to life, safety factor, or use of the product. The contacts used cost $26,000 per year more than seemed appropriate,

and an investigation was made. It was found that during the design work reasonable and appropriate contacts had been developed by test, and they had been selected. However, it was also found that, during the assembly process for preparation of samples to be sent to the Underwriters', something had gone wrong and the supply of the appropriate contacts had been exhausted. In order to avoid delay at the time, the engineer had furnished another, more expensive contact to the assemblers. This had solved the assembly problems and the samples had been made and sent to Underwriters' Laboratories where they had received approval. Two years later, with this information in hand, the appropriate contacts were submitted to the Underwriters', and of course, approval came forth with the result that the unnecessary, noncontributing cost was eliminated. Searches often disclose the unexpected.

The work of a business is twofold: to provide something which the public wants and to provide it for low-enough cost. The business will succeed or fail according to the effectiveness with which management makes decisions in these two areas.

The relationship of value analysis to management, of course, falls in the second category, hi the past, there have been severe organizational shortcomings. High among them is the fact that most important responsibilities can be effectively delegated and the degree of their accomplishment measured so as to be known. For example, the president or general manager delegates:

To his engineering head, responsibility for performance and design quality

To his manufacturing head, responsibility for production quality and I schedule

To his industrial designers, or the engineering head, responsibility for competitive appeal and features

To the manager of inventory control, responsibility for keeping inventory within the established ranges

To each of these men, that which is delegated is the prime job. Success or failure depend upon accomplishment in the assigned area.

When it comes to value, this is everyone's business. Each party is told to coordinate and cooperate with the others to secure good value. Attainment of good value is a "second job" under clear delegation and indefinite evaluation.

Experienced managers have often said that one of their major problems is that they have h little choice, no matter how much they were in need of lower costs, but to have the same people re-examine their work of the past. The result has been that a very negative, unrewarding, a inefficient job has been done.

With the advent of value analysis techniques, this vital problem of management is being corrected. The manager may now arrange for a suitable number of competent men to learn how to handle value. He may delegate directly to them responsibility for achieving certain value objectives. This becomes their job and they succeed or fail according to their performance on this one objective. Accordingly, the magnitude of results is of a different order.

The best managers agree that where management places emphasis, there they secure results. This they are enabled to do with the help of the value analysis suggestion sheet written in managers' language. The reader will recall that the suggestion sheet is a clear-cut presentation on unveiled solutions uncluttered by supporting data which are needed only by the engineer or other on-the-job decision maker. With the value information oriented to specifics, the manager may now apply effective emphasis to achieve the degree of value results which he feels the business needs.

Another important way in which the use of value analysis technique identifying, and helping to compensate for the costly disadvantages of the responsible people accumulate honest wrong impressions and, incurring more costs than necessary. Experience has shown that the costs to five times as high as is necessary to reliably accomplish the desire do much good by having his subordinates.

An important phase of the relationship of value analysis to management can be emphasized by me question: What is a most important responsibility of management to value analysis? The importance of the decision-making environment, which is largely under the control of the manager, was discussed. As a prime requisite, a manager, to enhance his earnings results, must provide an environment in which men can make decisions to obtain better value without the risk of personal loss. Full recognition and proper implementation of this situation by the manager can more than double the rate at which good value alternatives that deviate from past practice are put into use to retain product reliability and quality and to provide increased earnings.

Purchasing

A significant part of the responsibility of the value analyst, after the functions required have ~en determined, is to locate in the vendor market the particular product, process, or know-how rich will bring the best answer at the lowest price. Therefore, close and extensive relationships must exist between purchasing and value analysis.

Fortunately for both operations, effective value analysis greatly improves the grade and degree purchasing work, and efficient execution of certain purchasing activities greatly improves the degree and amount of value analysis accomplishment.

A large quantity of special metal dials was being purchased. They cost 90 cents each but purchasing had been able to get no other bids.

A value consultant studied the functions. They were found to be very similar. Discussions were arranged with the supplier, whose attention was called to purchased and to the simple function of the dial, as well as to the fact that t ana cents.

When the chips were down during the negotiable patented." It was such a simple product, however, that the patentability of it patent attorney was consulted, and when he got in touch with patent p received information, on what was patented. It proved be only

he detail which was being put. The result was that the supplier proposed a price of 40 cents instead of 90 cents. He stated that, although a quotation of 30 cents might be expected, he felt that his pioneering work in the field of dials had been important and that even though the precise item he had patented was of little value, it seemed reasonable to him to receive a 'O-cent payment for it. This was a well founded contention.

The matter was concluded by deciding to continue buying the dials from him, but for 40 cents rather than 90 cents. This resulted in saving a large amount of the cost of the military product involved. Investigation of questionable patent situations, as well as of any other situation which might odd cost, is a part of value analysis.

To those using the value analysis techniques, purchasing can supply valuable information about specialty-vendor knowledge and precise data regarding individual companies' personnel, products, or processes. The following value, analysis techniques can be most efficiently used only with continuous purchasing support.

Use industry specialists to extend specialized knowledge. Utilize vendor's available functional products. Utilize and pay for vendor's skill and knowledge.

Utilize specialty processes. Utilize applicable standards.

Purchasing men, situated as they are at the point of transfer of the company's money for materials, products, and services, often have reason to suspect that good value is not being obtained on particular items. In such circumstances, their invitations to value consultants to study the items, combined with their suggestions as to where to turn and how to obtain efficient work, almost always prove highly profitable.

The work of obtaining full value for expenditures, which is in keeping with the attainment of higher earnings, can be inestimably enhanced by the effective use of value analysis techniques by competent persons trained and skilled in applying them. As functions are studied and further clarified, value alternatives come to light. Discussions with technical people crystallize the alternatives that are practical, usable, and accept- able from the technical viewpoint. This allows purchasing people to buy a material or a product which may be entirely different from that originally intended but which is obtainable at very much lower cost and still is functionally useful. The result is satisfaction in a job well done.

It should be observed at this point that full recognition of certain basic premises is necessary for the effective interplay of the relationships in question. These premises are:

The value analyst will not do the buyer's job. Unless the value analyst has a complete prior understanding with the buyer, the interest that he takes in vendors and his communications with them will be questioned. As the buyer sees it, this is his corner of the ball diamond, and .now the value analyst is on it. Quite naturally he wonders: What is he doing in there? What is the effect going to be on my job? How will the efficiency and effectiveness of my work be affected? In the past I have enjoyed contacts even with the technical people of the vendors and have progressively learned from them. Will the value analyst's work now reverse this trend and steadily weaken me in the area?"

These and allied questions will interfere with the buyer's performance, and it is imperative for him to know that the value analyst will not do his job and also just what the value analyst will do. With a precise understanding of the relationship of value analysis to his job, the buyer will recognize that it

will extend his range, increase his competence, promote his growth, and enhance his contributions to the company's earnings. The value analyst will not be making decisions which were formerly the buyer's, but he will be providing more information for the buyer to 'work on so that he can make more rewarding decisions.

2. The buyer must be kept advised. If the buyer, as well as the company, is to benefit from the value analyst's activities, the buyer must be protected from any embarrassment that could result. Therefore, he must be a party to whatever work is being done in his area. This does not mean that he personally needs to expend time sitting in on all discussions.

It does mean, however, that the value analyst will let him know what is going on and will give opportunity to take part, to the extent he wishes, in discussions leading to later purchases. The technical people to work with competent vendors on projects involving considerable com thoughtlessly at the answers to the various problems so that the purchasing decision is by step by others than the buyers. This is contrary to the philosophy of good management under which a specific person is assignee responsibility for each major activity, such as engineering, manufacturing, sales, purchasing.

Thus management expects the purchasing manager and his organization to be responsible for properly purchasing any particular product. When, during the cooperative development of I purchasing decision, the purchasing people are not properly advised of the steps along the way but are told only of the final answer, they become, in effect, rubber-stamp manipulators who blindly place orders and abdicate their responsibility to make sure that their purchases represent value. If they refuse to follow the decision and open the project to bidders who have not had time either to learn all of the intricacies of the job or to make substantial financial and technical contributions to its development, their action may result in injury to the competent vendor who originally worked with the technical people as well as harm to their company. The product thus selected will probably not be up to standards when it arrives from the new vendor; and the result will be additional injury to the purchasing department, which becomes subject to criticism by management, and, in the final analysis, to the customer, who may not receive on time the product he had a right to expect.

A few simple ground rules and a reasonable amount of mutual understanding provide for a very rewarding cooperation between purchasing people

and value consultants. For anyone who expects to be using value analysis techniques, it will be profitable to examine some of the purchasing practices which would be affected, adversely or favourably, by his work: The following extracts are offered from a set of guides which have stood the test of usage.

PURCHASING PRACTICES PERTINENT TO THE PROPER RELATIONSHIP BETWEEN VALUE ANALYSIS, THE PURCHASING FUNCTION, AND THE PURCHASING MAN

These statements and purchasing practices are guides to be used with intelligence and with consideration of the other fellow and his job.

1. Sources of Supply

The purchasing department will select sources of supply interests of the company and with a view to creating and maintaining asked to bid, they must know that the source has not already been Strong and enduring relationships with tested suppliers a fair dealing, with maintenance of quality, delivery, and fair price the company to conduct purchasing so that suppliers will value" meet legitimate competition.

a) Buyers will buy from sources with good reputation and sufficient financial standing to meet the job requirements.

b) The best bid on the combined bases of price, quality and service will be accepted.

2. Commitments

b) The purchasing department conducts and concludes all negotiations affecting purchaser, selection of vendor, prices, terms, delivery, adjustments, etc.

c) Commitments and orders, to be valid, are to be stated by a letter, a purchase order, or a contract which sets forth appropriate details and which is signed by the purchasing agent or by a person duly authorized to sign in his stead.

d) Negotiations leading up to or apt to conclude in. contract arrangements should not be undertaken without the knowledge and authorization of the interested buyer in the purchasing department.

e) No one who is not a member of the purchasing department should commit himself to any vendor on preference for any product or source of supply for any product or give any information regarding competitive performance, final approval, or price.

3. Vendor Relations

The purchasing department, realizing that good vendor relations is a company asset, must be alert to promote a program of equity all d friendship with sources of supply.

a) Salesmen will be received in the purchasing department and ill other departments after arrangements have been made by the purchasing department.

b) In addition, the purchasing department will arrange interviews between company production, engineering, research, and maintenance personnel the advantage of the company or when the buyer is ill doubt as when such an interview has been requested by an appropriate

c) All suppliers' representatives are to have a complete hear till time they call. Subsequent policy will depend on the pa: prompt reception of salesmen is part of the code; if the into a prompt acknowledgment of the call, together with a real buyer, or any other company person, is not required to put his at the disposal of any and all comers, however frequent at whatever may be calling. the salesman elects to press them. The buyer must necessarily be the judge, but not relieved of his obligation of courtesy.

d) The purchasing department will handle all correspondence with suppliers except technical details make it desirable to secure technical or other assistance.

e) Requests for prices, trial lots, etc., should be made by the purchasing department.

e) When a free sample is accepted for test, an obligation is assumed by the company make a fair trial and to inform the vendor of the outcome of the test. However, preferred practice, the company may buy sample lots, thus incurring no obligation establishing the interest of the company in completing the trial and making a fair relation.

g) In fairness to all concerned, prices and other specific information received from vendor are considered confidential. The quotations of lone supplier may not be divulged another and such information c should not be circulated indiscriminately within company.

h) Buyers should be reasonable in requesting supplier's technicians to call, unless volume business justifies such expense. Information can ordinarily be obtained by letter, phone, or telegraph.

4. Inter- department Relations

The success of the purchasing department depends on the kind of job it does in procuring materials, equipment, facilities, ideas, and sup- plies. The most effective functioning of the purchasing department is possible only when other departments perform well their functions of engineering planning, receiving testing and storing. Therefore, intelligent, constant, and harmonious contact between purchasing and other departments relative to their needs and the procurement of the needs is a "must."

I)

a) The purchasing department has the duty and authority to ask reconsideration of specifications or quantity of material if, in the opinion of a buyer, it appears that the internal of the company may be better served. However, the final determination of actual of the engineering and requisitioning departments.

1I) Purchasing specifications, while written by engineering department before being issued to be sure material is obtain;

(a) It is desirable that the drawings for new-purchase advance of the required date as possible, to allow purchase

b) Buyers must be alert to pass on to potentially interested individuals information derived m salesmen's interviews and direct mail or other advertisements annul deemed useful. In a similar manner members of other departments are expected to reciprocate by drawing items deemed to of value to the attention of the purchasing department. If the purchasing department does not e a record of, or experience with, the items, suitable inquiry will be made by its personnel.

While value analysis is not as directly related to quality control as it is to purchasing or engineering, one specific relationship exists with extensive opportunity for mutually beneficial activity, re dealing with it, it will be well to identify two important areas of possible misconception about relationship of value analysis to quality control.

These two misconceptions, which are entirely too general, are:

I. "The function of value analysis is to identify and cause to be removed all costs which vide extra safety, extra quality, and extra life beyond the minimum needs .. It is the aim of value -sis to remove all of the quality which can be eliminated without having the product fall apart in customary use."

This statement is totally false in every degree of its implication. The use of the value analysis techniques identifies unnecessary cost, i.e., cost which does not add to safety, to performance, to life, to the appearance desired by the customer and which, in fact, adds nothing whatsoever to the duct under any condition.

II. "Lower cost means lower quality." This common belief, which is often inherited from early wildwood and which normally persists to control vital decisions, is also entirely false. Cost has no direct relationship. Indeed, it frequently occurs that the highest cost gives the lowest laity. The reader will add greatly to his value competence if, at this point, he frees himself of any flaunting tie to his childhood experience of buying small oranges for 2.5 cents a dozen and larger for 10 cents a dozen.

The reason for the existence of any product is that it accomplishes a certain function or a in group of functions. Good quality comes with the selection of good answers to the question how to use materials, processes, parts, and human efforts to accomplish these functions.

answers to the question. It is as simple that.

Now, to introduce cost in its proper perspective determination, Good quality products result whenever the answers chosen are good answers whether be high-cost answers or low-cost answers.

Poor-quality products result whenever the answers selected are un- reliable answers, when they are high in cost or low in cost.

5.7 CASE STUDY-6 LOWER COSTS MAY MEAN DOING IT THE RIGHT WAY

Precision gear sleeves, about 2 inches in diameter and 5 inches long, were e used precision product with expanding volume. They were manufactured in the plant at a cost of $1 each. Extensive inspection was required, as this was both a high-temperature and a high-speed on which even minute imperfections had to be eliminated.

As the volume increased faster than the production facilities for manufacture, it bee necessary to locate another source. Considerable purchasing effort produced a source which suitable gears. However, the cost was $17 each.

After being assured that the ten gears were built on the equipment which was put in place for the production order, a release of one hundred was is-

sued. These hundred were also of the same hitherto inexperienced high quality. This was followed by a release of a thousand, also of the same high grade.

Two interesting results followed. First, the inspection department, after days of making the inspection and never finding any flaws, began to feel that inspection was superfluous, and a simple checking routine was established which eliminated 95 per cent of the inspection of the gears from this supplier. Second, inspection personnel started putting strong pressure on the procurement department and on the factory to discontinue buying from the $17 supplier and also to discontinue plant manufacture of the item so that the extensive inspection required on gears received from the two sources could be permanently and totally discontinued.

The outcome was that the $ 17 supplier was dropped. But, in order to have a second source supply for the vital part should a serious problem of any nature and production temporarily in the $6.75 supplier, 25 per cent in-plant production was continued.

Scores of cases of this type prove to the experienced that good quality is the result of "doing the right way." So is good value.

As stated repeatedly in the foregoing discussions, the operation of value analysis is to identify functions clearly and then to search out and develop, by using value analysis techniques and overall knowledge, good answers for the lowest cost. No quality reduction is involved. However, if all problems are present at the start of the value study, quality improvement will result.

With the factual situation in clear focus, it will be recognized that value analysis and quality will have joint opportunities. Value analysis techniques can have an important impact on the solving of quality problems, and in turn, the quality control activity is an important means of, focusing the areas in which contributions can be made by the use of value techniques. Whenever problems exist, it means that the functions involved are not being secured in a suitable manner.

It may be divided into three classes:

Existing products

New products

Products adapted to customers' special requirements

With regard to existing products, the sales department must provide to customers performance features and attractiveness they want at competitive prices. Often, costs in company to competition are too high, and the sales

department is unable to sell until lower costs established. Lowering of costs by the required amount is invited and supported by the use of value analysis techniques in important areas of the product.

In the development of new products, it is incumbent upon the sales department to determine what functions, or what combinations of functions, the customer desires and, further, to determine at about what market price these functions can be sold. It is at once apparent that the department is here dealing in functions and costs, which are the stock in trade of value analysis, opportunity exists for value consultants to apply the special techniques and the special knowledge toward the development of value alternatives which will provide a sound basis for investment planning, advertising, staffing, etc., to provide the new products.

In connection with customers' special requirements, the value analysis techniques are tools studying with them precisely what their needs are. With a clear understanding of the function, functions, a customer needs, sales people are enabled, by providing the precise new functional components required, to effectively adapt their products to accomplish most economically the need of the customer.

Viewing the relationship from the opposite end, it will be seen that sales provides to value consultants important areas of opportunity. With regard to established products, they know precisely where to work to meet the company's emergencies. In connection with new products, they know the considerations which should receive top priority in the new product line and can make contributions that will have long-standing high value. As for special products, they have the extra opportunity of using their techniques to help secure specific additional orders.

In the area of accounting, value analysis encourages the use of meaningful costs. Meaningful costs bear the same relationship to good decisions among "cost" alternatives that meaningful tests do among "performance" alternatives. A value analysis organization helps accounting people contribute to better decisions by encouraging use of costs that are meaningful for the purpose of comparisons.

Appearance design people are assisted by the separation of the aesthetic from the use function, the separation of the costs that go into aesthetic functions, and the emphasis value analysis places upon providing an opportunity for them to use their special abilities and skills on the product.

Every technique of value analysis is so constituted that when utilized by cost-reduction people, a far greater yield per man-hour results. Cost reduction is a part-time activity of everyone. It is essential to normal operation. Value analysis is a full-time activity of a few with special training, techniques, and skills. Both have the objective of minimizing unnecessary costs.

Engineering people are assisted at every turn by the operation of the value analysis system.

Essential information is gathered for them. Functions that they must provide are made clearer. Costs that they need are developed for their decision making.

Manufacturing people find that the functions provided by the operations they must perform are often evaluated, and less troublesome or less costly means for achieving the required purpose re brought into view. They find that alternative means for accomplishing functions help them to remove unsatisfactory operations from the factory. Value analysis search techniques often uncover materials or processes that they can examine and include.

Furthermore, value analysis brings a good answer to the dilemma of management people, early all essential work, excepting that of securing good costs, can be assigned to a competent group: performance of the product to engineering, quantities of production to manufacturing, volume f sales to marketing. The results are measured-they are suitable or they are not-and proper corrective measures can be taken. However, the vital factor of proper costs, in a competitive business, is a matter of conversation and harangue. It is "everybody's" job. It is not assigned, and performance is not measured as are other vital factors. Properly staffed and assigned, value analysis people will accept the assignment of assuring proper costs. They have the goals to accomplish it, and it can be measured by the competitive cost results.

Those responsible for the control of quality are assisted by the problem-solving system of value analysis, which finds better answers to engineering, manufacturing, and purchasing problems. Good quality is the result of "doing it the right way," which results from the use of the value analysis system.

The vital sales responsibility to know "for sure" what functions the customer wants and is willing to pay for is emphasized as the very start of high-grade value work. Help is provided when needed. People are provided with clear statements of the functions the engineering and manufacturing departments are striving to provide and with the "value" (lowest known cost) of producing each of the functions. They are supplied with alternatives that provide various benefits for their discussions with customers and for their evaluations.

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CHAPTER-6

VALUE AND DECISION PROCESS

6.1 INTRODUCTION

Value Engineering(VE) decision process is otherwise called Value Engineering job plan. Miles' Job Plan was a modified version of work study. Later, several approaches have emerged. The job plan is a systematic approach to identify the key areas of unnecessary cost and to seek new and creative ways to perform the function without compromising the reliability. This enables the study them to define the requirements clearly and to assess the true function. It uses function analysis to classify the components of the product or project into those performing the true function or required function and those performing the support functions. Job plan is the systematic approach of Value Engineering. It is a road map for defining the required task and determining the most economical combination of functions to achieve the task.

A VE programme is an organised set of definite tasks which support or apply the VE discipline to all major cost elements of an organization. The word "organised" is significant. Unless planning, scheduling, measurement and other control procedures are applied, one does not have an effective VE programme. "Definite tasks" indicate that the programme elements must be stated (and understood) in sufficient detail to be logical entities which can be assigned, staffed , costed and assessed.

The most commonly used job plan procedure is the standard five phase job plan procedure is the standard. Five phase job plan, which consists of the following phases

1. Information Phase
2. Creative Phase
3. Judgment phase
4. Development phase
5. Recommendation phase

The job plan provides the framework for undertaking VE in a planned and systematic manner. The Job Plan represents a concerted effort to furnish the best answers to the following "Key questions".

What is it? What does it do? What must it do?

What must it cost?

What is it worth?

Who else might do the job?

What will that cost?

What will satisfy all the needs of the users?

What is needed to implement it?

6.2 PHASES OF VALUE ENGINEERING

The Value Engineering Systematic Approach described here consists of a seven-phase job

1. Project Selection Phase
2. Information Phase
3. Function Phase
4. Creative Phase
5. Evaluation Phase
6. Investigation Phase and
7. Recommendation Phase.

6.2.1 Project Selection Phase

Objective:

To select those products, processes or systems in an organization, when value to cost ratio is low and where analysis will lead to increased profitability.

Possible VE project within an establishment will include product designs, materials, fund hardware, consumables, technical data etc. It includes almost anything within the assigned responsibility of an activity.

In the early stages of a VE programme, sophisticated project selection criteria are not needed. Frequently there are numerous areas where the need for VE is obvious and which offer substantial return on investment. To ensure co-operation and implementation, VE projects are be selected in such a way that these projects involve an ample Rupee expenditure

- deserve attention for reasons other than cost and
- are encouraged by management

As the programme matures and the opportunities become less obvious, additional criteria may be used to select subsequent tasks.

One common method of selecting projects for VE is to subject the project or service to the following tests for value. If most of the answers do not indicate good value, then it can be taken up as a VE project. The questions are as follow:

i) Does its use contribute value?

ii) Is its cost proportionate to its usefulness?

iii) Does it need all its features?

iv) Is there anything better for the intended use?

v) Can a usable part be made by a lower cost method?

vi) Can a standard product be found that will be usable?

vii) Is it made on proper tooling considering quantities used ?

viii) Do material, reasonable labour overheads and profit total its cost?

ix) Will another dependable supplier provide it for less ?

x) Is anyone else buying it for less ?

Initially VE projects may be selected on the basis of monetary benefits. Later on, project selection may be based on such additional factors as appearance, ergonomics, improved reliability etc. The job plan schedule for VE project work should then be prepared.

6.2.2 Information Phase

Objectives:

To gain an understanding of the Project being studied and to obtain all essential facts relating to the Project, as also to estimate the potential value improvement.

All the essential information should be assembled, such as specifications and drawings, parts list, weight of parts, cost of parts (materials, labour, overheads), names of suppliers, manufacturing methods and requirements of the user.

The limits and restrictions of the study are as given below;

It may be necessary to discuss the product with sales, design engineers and it is also necessary to decide on the approach to be used.

To study the entire product (or system),

To divide into assemblies or functional area and study each

To study the individual parts in turn.

The amount of information assembled will depend on this decision. For example, the weight and cost of individual components will probably be unnecessary if an alternative to the whole product is sought.

It is useful to establish the amount of time which should reasonably be expended, taking into account quantities, costs, other work etc., and to establish a rough target of the savings likely to be achieved.

6.2.3 Function Phase

Objectives:

To decide the area of analysis and the functions that it actually performs and is required to perform and to relate these functions to the cost and the worth of providing them.

Once the team has selected a project for value analysis and gathered all relevant data concerning it, the next step is to define the functions that have to be performed by the object or assembly. At first this may seem trivial and almost unnecessary, but in fact, it is a very important step for the procedure since all subsequent actions originate from this.

The rules of function definition are:

i) The expression of all functions must be accomplished in two words-a verb and a noun, ii) Functions should be categorised as either primary or secondary functions.

The objective of this stage is to identify, simply and unambiguously, the task to be carried out by the item under consideration. It is preferable to do this in two words -a verb and a noun. A description that contains more words than this is likely to include more than one function, which defeats the object of this exercise. The following are typical functions:

Make mark; indicate level; facilitate machining; restrict movement.

While brevity is to be aimed at, it is sometimes preferable to use three words if this permits a more specific definition to be achieved, e.g.

Indicate circuit available; allow correct selection; prevent oil leakage.

The more specific the definition of a function the easier it is. For example, if the functions of a cigarette lighter had been excluded all types which did not produce a flame, such as the cars. 'Provide ignition' would have been more specific. It could be argued that 'light cigarette' is the correct function but on examination 'light cigarette' is not the only requirement of a cigarette lighter. Its functions can include 'light stove', provide light etc. Similarly, the function of a refrigerator is not 'to reduce temperature' -that is how it achieves its function, which is correctly defined as 'preserve food'.

It is necessary to bring in a qualification at this stage to make the function more specific. The importance of this becomes even more apparent when the costs of a function are being evaluated or compared. After the function its specifics are stated, e.g.

Function	Specifics
Support load	500 kg static constant load
Conduct electricity	5 amps at 220 V with the maximum temperature increase of 20°C.

In most cases a component has more than one function. However, one is usually more important than the others. Functions are thus classified as primary or secondary by the following definitions.

Primary Functions : is the basic or specific purpose for which the component or assembly was designed. The primary functions or basic functions must be provided if the item is to possess the essential utility needed by the user.

Secondary Functions : A function is described as secondary if, either it does not directly contribute to the basic function, or it is only needed to support the achievement of a primary function due to design, method, life or finish. Secondary functions play an enabling role. They are provided merely to make the basic function(s) achievable. Secondary functions are considered to make no direct contribution to the worth, but do add directly to the cost. Consequently value improvement efforts aim to minimize the number of secondary functions provided.

After having defined the functions, the next step is to establish the worth of each basic function. The objective of obtaining the worth of function is to:

- Determine which are the poor value functions and whether the VE effort should be continued.
- Obtain a reference point from which the cost of alternatives can be compared.
- Formulate a target cost or goal, to provide a psychological inventive to discourage a premature relaxation of the VE effort.

Some of the methods of evaluating functional worth are:

i) Comparison with known cost of performing the same function in other devices, mechanisms or services.

ii) Comparison with known costs of performing similar functions,

iii) Comparison with known costs of items similar in appearance and size,

iv) Comparison with estimated costs of performing the functions by the simplest means,

v) Apportioning a percentage of the total worth of the whole project,

vi) Comparison with competitors' selling prices for parts which perform the same function.

vii) Estimating the effect on operating costs of a change in the cost of providing the function (exchange rates or cost benefit analysis).

viii) Theoretical evaluation of function cost.

ix) Allocation of arbitrary worth.

x) Sometimes the intuitive comparison of the cost of two items is sufficient to indicate which represents the best value. In many cases a measurable parameter must also be added in order to provide a realistic comparison. The functions requiring their cost-worth to be expressed in this form should be obvious from the verb and noun description, i.e. a verb and a measurable noun e.g.: Cost per unit of length; Cost per unit of heat; Cost per unit of weight.

6.2.4 Creative Phase

Objectives:

To produce ideas and to formulate alternative ways for accomplishing the essential functions and improving value of the problem under consideration.

This effort begins as soon as enough information has been gathered, reviewed and understood. The first step is to try and answer the question: "What else will do?"

Creative problem solving techniques are used to discover alternatives that will provide essential functions at the lowest possible cost. There are several formal idea stimulation exercises that may be used during this phase of the VE study. All seek a great number of ideas. The greater the number of ideas conceived, the more likely that among them will be something that will eventually lead to better value. Judgment as to the practicality of an idea is deferred to a later stage. Departure from ordinary patterns, typical solutions, and habitual methods is encouraged, because it may be the new, fresh, radically different approach which leads to a better value solution. Creativity is the development of ideas new to the individual. Idea stimulation techniques encourage the generation of objective solutions. Everyone possesses some degree of creative ability. Innate creative ability can be roved through training and practice. The application of creative techniques to problem solving is a step-by-step sequence. Innovation or creation is not always the result of consciousness. However, some of the typical ideation exercises undertaken during a VE effort are used here. The ground rules for creative idea generation may be summarized as follow:

- Do not attempt to generate new ideas and to judge them at the same time. Defer all judgments and evaluation for some time.
- Generate a large number of alternative solutions. As a goal, multiply the number of ideas produced in the first rush of the thinking by 5 or even 10.
- Seek a wide variety of solutions that represent many different approaches to the problem.
- Watch for opportunities to combine or improve ideas as they are generated (termed "hitchhiking")
- No idea, even the most impractical is discarded.
- There is no place for ridicule of ideas.
- Before concluding the idea stimulation exercise, allow time for subconscious thought on the problem while consciously performing other tasks (termed "incubation").

6.2.5 Evaluation Phase

Objectives :

- To select for further analysis the most promising of the ideas generated during the creative phase.
- To subject the ideas to a preliminary screening to identify those which satisfy the following criteria :
  - Will the idea work?
  - Is it less costly than the present design?
  - Is it feasible to implement?
  - Will it satisfy the users' needs?
  - If the answer to any of the above is "no", can it be modified or combined with another to give a "yes" answer.
- To determine which is the most suitable proposal and obtain its cost.

In any Value Engineering exercise the production of a large number of ideas is possible. It is necessary while evaluating each of these proposals or while comparing with the existing solution to make an objective judgment, unspoilt by habits, attitudes, individual preferences or pre-conceived notion. In particular it must be remembered that it is not only a question of assessing the cost saving of an idea which determines whether it should be considered further. Such a practice degenerates into 'cost-reduction', whereas better value may lie in choosing a more costly idea. In this connection the VA question that is posed in the Evaluation Phase of the Job Plan i.e. "What will be that (the best alternative) cost?" should not be taken to imply that cost is the only criterion. Certainly, it can be an important one and the selection of ideas which are more costly can be ruled out as probably being unacceptable, thus providing a simple selection process.

6.2.6 Investigation Phase

Objectives :

- To bring partially developed or untried ideas to fruition and to determine their feasibility and drawbacks.
- To construct a work plan for converting the preferred ideas into tangible proposals.

In this phase the selected ideas are further refined into workable and salable solutions, providing lower cost methods of performing the required and desired functions through the application of additional, vast resources of

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knowledge. This portion of the effort includes developing detailed technical and economic data for the proposal building models and prototypes, prototype testing and refining, of the proposal.

In some instances proof of the technical acceptability of a concept can only be demonstrated by extensive testing. Such extensive testing is not usually a part of the typical VE effort. However, limited tests are occasionally conducted to demonstrate the feasibility of a concept. This phase also includes determining the type, probable duration, and cost of any test programme which may, ultimately be required to prove the acceptability of a proposed alternative.

6.2.7 Recommendation Phase

Objectives:

- To prepare and submit the planned proposals with benefits and drawbacks to the management and
- To review the proposals, if for any reason not acceptable to the management

The VE terms recommendation of the selected proposal should be submitted in a specially made summary book. This book will give an overall picture of the entire project. The completed proposal should include an accurate description of the change as well as the cost impact and savings initial. The cost estimates should be of sufficient accuracy to support the validity of the savings initial calculation. The proposal must indicate that the proposed savings . All costs involved in making the proposed change must be included. A listing of functions, the objectives of the VE investigation and a brief description of the existing and proposed methods must be included.

Any advantages or disadvantages, or no effect on the following factors must be mentioned;

Reliability, Maintainability, Usability, Productivity, Appearances, Parts availability; Production lead Quality; Weight, Performance, Packaging etc.,

The Recommendation Phase is the culmination and wrap-up of all the previous efforts exerted out of the Job Plan. Upon its diligent fulfillment hinges the success or failure of all foregoing. A multi discipline experienced personnel carries out each of these phases.

Check your progress

1. What is VE decision process?
2. What are the various phases of VE decision process?
3. List the phases of Job plan?
4. What is investigation phase?
5. What is Recommendation Phase?

6.3 SUMMARY

A VE programme is an organised set of definite tasks which support or apply the VE discipline to all major cost elements of an organization. The

word "organised" is significant. Unless planning, scheduling, measurement and other control procedures are applied, one does not have an effective VE programme. "Definite tasks" indicate that the programme elements must be stated (and understood) in sufficient detail to be logical entities which can be assigned, staffed , costed and assessed. The Value Engineering Systematic Approach described here consists of a seven-phase job

1. Project Selection Phase
2. Information Phase
3. Function Phase
4. Creative Phase
5. Evaluation Phase
6. Investigation Phase and
7. Recommendation Phase.

6.4 ANSWER TO CHECK YOUR PROGRESS

1. **What is VE decision process?**

   Value Engineering(VE) decision process is otherwise called Value Engineering job plan. Miles' Job Plan was a modified version of work study. Later, several approaches have emerged. The job plan is a systematic approach to identify the key areas of unnecessary cost and to seek new and creative ways to perform the function without compromising the reliability.

2. What are the various phases of VE decision process?

   The Value Engineering Systematic Approach described here consists of a seven- phase job

   - Project Selection Phase
   - Information Phase
   - Function Phase
   - Creative Phase
   - Evaluation Phase
   - Investigation Phase and
   - Recommendation Phase.

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3. List the phases of Job plan?

The most commonly used job plan procedure is the standard five phase job plan procedure is the standard. Five phase job plan, which consists of the following phases

- Information Phase
- Creative Phase
- Judgment phase
- Development phase
- Recommendation phase

4. What is investigation phase?

   In investigation phase the selected ideas are further refined into workable and salable solutions, providing lower cost methods of performing the required and desired functions through the application of additional, vast resources of knowledge.

5. What is Recommendation Phase?

   In the Recommendation Phase, the proposal should include an accurate description of the change as well as the cost impact and savings initial. The cost estimates should be of sufficient accuracy to support the validity of the savings initial calculation. The proposal must indicate that the proposed savings .

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SCHEDULING OF VALUE ENGINEERING ACTIVITIES

7.1 INTRODUCTION

The value Engineering activities are being identified and care should be taken to ensure that these activities are carried out on time. For this purpose the time duration for each of these activities are identified. The sequence and the timing of these activities are decided well in advance.

The Scheduling techniques which will come handy in managing the value Engineering activities such as critical path method (CPM). Project Evaluation and Review Technique (PERT), Gantt Chart and Control Charts.

The activities in each phase of the job plan are being identified. The sequence and the timing of these activities are determined. Then these scheduling techniques are employed to ensure the smooth implementation. If the value Engineering job plan.

7.2 PHASES OF VE

Another Model which has also been successfully adopted by the VE experts is explained in the following paragraphs. It consists of information, creative, judgment, development and recommendation phases.

Information Phase

The Purpose of this phase is to gather maximum information and knowledge about the product or project. It involves defining the functions of the product, obtaining the background information that lead to the design, limitations and sensitivity to the costs involved.

It it to be borne in mind that the designer would have paid utmost care in developing the specifications. The value engineering team gets information that led to the development of that particular design. What is the logic behind such design decisions? What are the assumptions made by the designer in deciding the design criteria? What are the reasons behind choosing the materials, size shape and other parameters?

These questions are being raised with the intention of coming out with different alternatives and comparison of the same.

One of the first assignments of the value engineering team is to analyse and validate the cost information. The cost associated with different designs of the product as well as with the different materials is to be ascertained. In the case of project, the cost must be broken down into the various components or elements of the project. A complete cost matrix needs to be prepared.

The functional analysis which involves categorization of the functions of a product project into main/basic function and supportive functions. Then the cost and the worth related to each functions is then identified.

The overall system costs are compared with the sum of the worth of the basic functions. Worth is nothing but the minimum cost required to perform the function. If the cost-worth ratio is greater than 2, the prospect of reducing cost is bright

Creative Phase

This phase is designed to induce the value engineering team to think beyond the normal ways to which it is accustomed to the creativity of the team members is expected to be applied intensively during this phase.

Ideas stem from the work done during the information phase as well as from creative sessions. During such brainstorming sessions, all the speculative ideas are noted down. Complete listing of each and every idea is done before analyzing and hedging any of the ideas.

Every individual is given a chance to come out with his creative idea. No criticism or judgment is done at this juncture, we team looks for as many ideas as possible and also for the relationship between these ideas.

Usually people follow the behaviour of other people and they come out with their contribution promptly when they take part in a group session where the other members are expressing their ideas. A multi functional group exercise will load to a variety of ideas with different points of view.

Judgment Phase

During the judgment phase, these ideas which have been listed during the creative phase are being screened. The merits and demerits of each of these ideas are separately listed, each idea is evaluated objectively to check whether the further development of the same may lead to enhanced value of the product or project.

All the listed ideas are evaluated based on the criteria such as cost, performance, variability and aesthetics. Some of the questions that are raised at the back drop of each of the ideas may be like the following:

What are the cost savings?

Does it meet the functional requirement?

Is it a reliable idea?

What will be the impact on the original design?

Will the changes to the original design be very costly?

Whether the new design has ever been used elsewhere? How does the idea impact the aesthetics of the product?

How does it affect the user convenience?

Can the new materials be procured without difficulty?

Can the existing production facilities be used as they are?

Will the changes in the production facilities be very costly?

What will be the impact on the production and the delivery schedules?

These questions when raised at the backdrop of each of the ideas will leave to critical and objective evaluation of the ideas. Even if the idea is not worthy of further development, there may be other areas where the ideas may work. Also an attempt should be made to combine two or more of the ideas for making a recommendation.

An objective way in which these ideas can be prioritised is as follows. Based on the relative merit and demerits, the ideas are rated on a 10-point scale. 10 being the most advantageous and 1 being the most disadvantageous points. Those ideas whose scores are high are selected for further development in that order.

Development Phase

Those ideas which have passed through the judgment phase are processed in the development phase that they can be developed into workable solutions. During this phase the following activities are carried out. The ideas are again

subjected to thorough research. Sketches of the proposed solution and preliminary designs are prepared cost estimates and reliability aspects are thoroughly forecasted. If the background information and complimentary calculations favour a particular change in design, then the change is considered for recommendation.

The technical competence of the VE team comes to the fore during the development phase of the job. The advantage of a multifunctional VE team is to be realised fully at this phase. Expertise in all related areas such as design, production, sales and purchase is to be utilized in the development of various design alternatives. The involvement of the original designer and his contribution will be much helpful during this phase.

The development phase comprises of the following activities.

a) Attempt new design
b) Analyse the difference between the existing design and the new one
c) List down the advantages and disadvantages of each proposal
d) Study the cost savings, performance and relabelling aspects of each proposal and
e) Discuss the implications and requirements to implement each recommendation

The impact of a design change on the other functional parameters of the product or project should also be properly studied. A discussion as to how these changes will have an impact on other areas in the design such as saleability, safety, reliability, aesthetics etc., should also be arranged for.

Recommendation Phase

If the recommendations of the value engineering team is not accepted, then the very objective of the value engineering team is not served. New concepts are not readily accepted, unless or oth erwise there is a strong reason for adopting them. These ideas must have special merits so that they may be accepted for implementation. :

In order to make this recommendation phase effective, a few guidelines are to be followed. Each idea must be well documented and must be summarised in a livid and precise manner. Secondly the design criteria should be adhered to. There should not be deviation from the design guidelines.

It is also imperative that the key decision makers are present during the presentation. It these are major changes in the design and that there will be a

definite delay in the implementation, then this cost escalation would be considered.

While the recommendations are made, the key decision makers such as the designers and the op-level executives should be present. An elaborate discussion at this stage will bring out more relevant points which might not have still been discussed. Also as the participation level increases, the reservation and the determination to implement the recommendations also go up. Consideration of others' views, courteous behaviour and good human relations will make this phase smooth and productive.

1. Information Phase.
2. Creative Phase.
3. Judgment Phase.
4. Development Phase.
5. Recommendation Phase.

7.3 GANTT CHART

Gantt Charts are visual aids that are useful in loading and scheduling. The name is derived from Henry Gantt, who developed them in the late 1800's. The charts show the use of resources, such as work centres and labour.

When used in loading, Gantt Charts show the loading and idle times of several departments, machines, or facilities. They display the relative workloads in the system so that the manager knows what adjustments are appropriate. For example, when one work centre becomes overloaded, employees from a low load centre can be transferred temporarily to increase the work force or if waiting jobs can be processed at different work centers, some jobs at high-load centers can be transferred to low-load centers. Versatile equipment may also be transferred among centers. An example is given below

A washing machine manufacturer accepts special orders for machines to be used in hospitals and hotels. The production of each machines requires varying tasks and durations. The company developed the Gantt Chart as given below:

<table>
<tr><th>Day / Work center</th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>Metal works</td><td>Job 1</td><td></td><td colspan="3">← Job 2 →</td></tr>
<tr><td>Mechanical</td><td></td><td colspan="2">← Job 1 →</td><td>Job 3</td><td></td></tr>
<tr><td>Electronics</td><td>Job 3</td><td></td><td></td><td>Job 1</td><td></td></tr>
<tr><td>Painting</td><td colspan="2">← Job 4 →</td><td>Job 3</td><td></td><td>Job 1</td></tr>
</table>

Center not available due to maintenance or repair work

The Gantt Load chart has a major limitation; it does not account for production variability such as unexpected breakdowns or human errors that require reworking a job. Consequently, the chart must also be updated regularly to account for new jobs and revised time estimates.

A Gantt schedule chart is used to monitor jobs in progress. It indicates which jobs are on schedule and which are ahead of or behind schedule.

Gantt Chart is used in the Scheduling of VE activities. Similarly other scheduling techniques can be used in the VE Process.

Open minded discussions and review is an essential step in the recommendation phase. The value engineering team should do its best to sell its recommendations. These should be a sincere attempt made to clear the apprehensions in the minds of the key decision makers. Each and every recommendation should be discussed separately. There has to be an earnest effort to convince and persuade the decision makers in the light of an objective appraisal of every recommendation.

The designers may have certain specific concerns. As the designer had worked on the design for months together, it may be disappointing for him to implement certain changes. The second reason is that these changes will make the co-ordination of the activities of different functional departments move difficult than that in the case of the original design. Thus it can be concluded that the salesmanship of the value engineering team plays a pivotal role during the recommendation phase.

NOTES

A CRITIQUE OF PERT AND CPM

Advantages

1. Useful when scheduling and controlling large projects
2. Straightforward concept and not a complex one
3. Graphical networks help highlight relationships among project activities
4. Critical path and slack time analyses help pinpoint activities that needed to be closely watched
5. Project documentation and graphs point out who is responsible for various activities

Limitations

1. Project activities have to be clearly defined, independent, and stable in their relationships
2. Precedence relationships must be specified and networked together
3. Time estimate tend to be subjective and are subject to fudging by managers.
4. There is danger of placing emphasis on critical path.

7.4 JOB PLAN BY MUDGE

On the other hand Mudge proposes the job plan in the following seven steps:

General phase, Information phase, Function phase, Creation phase, Evaluation phase, Investigation phase and Recommendation phase

Each phase has a set of techniques, carried in the work -sheets. V A is to be applied for those products where cost reduction potential is, substantially high. It is the general phase which acts as a framework for other phases. The brief description of these phases follows.

The resistance is generally of the following types:

1) "We tried this a couple of years ago but it was not successful".(Conditions change. Why not try again now?)
2) "It can't be done." (If it has not been tried how does one know?)
3) "The customer is satisfied with the price as it is." (If this is so, he will be more satisfied and so will many others if the price is reduced.)
4) "Sampling is not as accurate as 100% inspection". (This is not always true but in any case, does it need to be that accurate?)

5) This way processing would produce "too many rejects to the specification". (Then, are the design limits too tight?)
6) There is no other technique. (Have you looked for one?) People have a natural resistance to change which may be further conditioned by experience. But favourable experience will help to reduce the resistance. While thinking of doing VA, we must exercise good business judgment by being resourceful, thinking and innovative. The general phase is the foundation. We then enter the next phase-the in-I formation phase.

General Phase

It is the most demanding phase of a VE Job Plan. It creates the right environment for successful Value Engineering. In this phase, emphasis is placed on human inter-actions to seek co-operation of the team to implement Value Engineering. Work is done on specifics, rather than on generalities. The resistance to change is to be overcome. Some typical beliefs, habits and attitudes are given below.

"It will set a nasty precedent"

"It won't work"

"Cost too much".

"The Public won't touch it"

- "It is impracticable".
- "The Production Dept. will have none of this"
- "Why change it-it works".
- "There is no other source of supply"
- "That is not our responsibility".
- "The Management will not accept it"
- "It's company policy".

Information Phase

Here an attempt is made to assess the potential of value improvement. Project is studied in detail and all important facts are gathered and considered. In this phase, facts which are in the form of technical specifications or environmental specifications are considered. Also, the engineering drawings, production sample, production data are all kept in mind. The cost data and work specifications are secured. Consumer preferences are jotted down. Development and testing are studied. Quantities and scrap are taken into

account. A relationship is to be established between costs and specifications or requirements. Next stage is the functions phase. You will appreciate that lack of information is overcome in this phase.

NOTES

Lack of Information

Most people who design a product are quite often not too sure of the real needs of a user and usually over design the product by providing it with features that the user just does not use.

On of the facts of the Manager community is that they lack cost information. Most of them feel that they have a rough idea, but how rough is rough?

The world is advancing exceedingly fast and new technology, new products, new materials and new processes are coming up almost every day. They create obsolescence in respect of the ok materials or processes. Costs which were considered satisfactory yesterday become unnecessary today. In the tace of competition the royal road to ruin is to adopt the methods of yesterday to the business of today.

Function Phase

Here the product is defined in terms of its functions, in terms of its performance expectations. These functions are co-related with costs and their worth.

Most of the times, an attempt is made to define functions with only two words a verb and a noun. It makes the definition pretty sharp. It introduces an element of rationality into the exercise, by trimming the frills. Some examples will make you familiar with this approach.

Some Functional Definitions

Product	Function
Tea Cup	Hold tea (liquid)
Light Bulb	Emit light
Gas Lighter	Provide ignition.
Fan Regulator	Regulate speed
Match Box	Provide ignition
Mirror	Reflect light
Brake	Arrest motion
Screw driver	Transfer torque

NOTES

Another technique which is used under this phase is to evaluate functional relationship by ranking functions in descending order of importance. Simultaneously relative value of their importance is determined

Paired comparison method- is fairly common amongst researchers. It determines numerical value of various functions. Here pairs of functions are compared to know their importance and to assess the degree of variation (major, medium or minor).

Functions are defined tor the products as a whole and for all their components. Functions are either basic or secondary. Generally a product's basic function is one, but it may possess several secondary functions. Basic functions can be restated in more ways than one.

Creation Phase

Lack of Ideas

A survey done in the United States shows that most people use less than 5% of their creative abilities. "We have hardly any time" (to think?). Most of us want previously tried out materials, designs, processes and procedures. We jump at the first ideas that work and usually do not bother to find out if better methods are possible.

These days, to give a fillip to creative ideas, brainstorming technique is used. To nurture creativity, positive thinking is established. Creative ideas are also developed by a number of check-lists and idea-stimulator.

Evaluation Phase

Creative ideas generated during the above phase are screened for their feasibility, cost-effectiveness and practicability at this stage. For this purpose, ideas are further refined or combined together. Cost of all ideas and savings resulting from their implementation are studied. Decision-matrix can be set-up to evaluate on the basis of various criteria.

Investigation Phase

It is a virtual extension of the previous phase. Ideas accepted are here converted into acceptable and workable solutions to perform the desired functions at the least cost. It may be necessary to standardize, to consul', vendors and specialists, and to use specialty products, processes and procedures.

Recommendation Phase

It is the ultimate phase of VA. Finally the shortlisted value alternatives are presented for acceptance and implementation. Acceptance is the key to the success of VA. Sometimes, acceptance is a result of the significance of the

Check Your Progress

1. What are the various scheduling techniques?
2. What are the various phases of general VE model?
3. What are the steps of Job Plan by Mudge?
4. What is Gantt chart?
5. What are the advantages of PERT/CPM?

proposal or that of an impressive presentation, or a combination of both. All the relevant data is kept before management to enable it to make a suitable decision.

Sequencing of various activities can be done by following this model as well then the scheduling techniques such as CPM, PERT, Gantt chart, and Control charts can be used.

7.5 SUMMARY

Value Engineering activities are being identified and care should be taken to ensure that these activities are carried out on time. For this purpose the time duration for each of these activities are identified. The sequence and the timing of these activities are decided well in advance.

The Scheduling techniques which will come handy in managing the value Engineering activities such as critical path method (CPM). Project Evaluation and Review Technique (PERT), Gantt Chart and Control Charts. A Model which has also been successfully adopted by the VE experts is explained in the following paragraphs. It consists of information, creative, judgment, development and recommendation phases.

7.6 ANSWER TO CHECK YOUR PROGRESS

1. What are the various scheduling techniques?

   The various scheduling techniques are: critical path method (CPM), Project Evaluation and Review Technique (PERT), Gantt chart and Control Charts.

2. What are the various phases of general VE model?

   The various phases of general VE model consists of

   - Information phase
   - Creative phase
   - Judgment phase
   - Development phase and
   - Recommendation phase

3. What are the steps of Job Plan by Mudge?

   Mudge proposes the job plan in the following seven steps:

   - General phase
   - Information phase

- Function phase
- Creation phase
- Evaluation phase
- Investigation phase and
- Recommendation phase

4. What is Gantt Chart?

   Gantt Charts are visual aids that are useful in loading and scheduling. The name is derived from Henry Gantt, who developed them in the late 1800's. The charts show the use of resources, such as work centres and labour. When used in loading, Gantt Charts show the loading and idle times of several departments, machines, or facilities.

   The Gantt Load chart has a major limitation; it does not account for production variability such as unexpected breakdowns or human errors that require reworking a job. Consequently, the chart must also be updated regularly to account for new jobs and revised time estimates.

5. What are the advantages of PERT/CPM?

   Advantages of PERT/CPM

   1. Useful when scheduling and controlling large projects
   2. Straightforward concept and not a complex one
   3. Graphical networks help highlight relationships among project activities
   4. Critical path and slack time analyses help pinpoint activities that needed to be closely watched
   5. Project documentation and graphs point out who is responsible for various activities

ORGANIZATION FOR VALUE ENGINEERING

1.1 INTRODUCTION

Appropriate organization for the attainment of the best benefits of value analysis will be assessed first from a viewpoint of the overall business, second from the viewpoint of the men performing the work, and third from the viewpoint of the relationship between the men doing the work and the management of the business.

Performance orientation having been of maximum importance in the industrial development of the United States, normal management people have learned quite precisely how to effectively accomplish performance-oriented assignments. In these endeavours, cost has been recognized to be important to the extent that each person has given thought to value and has constantly taken certain conditions with reference to value. It has been expected that such actions will normally be taken in addition to carrying out the performance-oriented assignment.

This means that getting good costs has been and is generally considered by most managers to be somewhat similar to breathing. As the individual takes his bath, has his breakfast, and drives his car to work, he just continues breathing, and he does a reasonable job of it at all times without paying much special attention to it. Care is taken by the employer that air is provided for breathing, and care is taken by the employee that nothing obstructs his ability

to breathe. Otherwise, each continues the especially identified activities for which he has acquired certain training or skill.

Similarly, normal management believes that value is everyone's business, whether his specific assignment is to design the product, to handle, its drafting, to engineer its tooling, to layout the factory, or to do anything else. Periodically, emphasis is placed upon the importance of achieving value, i.e., periodic drives are made, during which men are relieved of other work in order to place more emphasis, for a time, on value. It is expected that an acceptable degree of value will be achieved in the product by this "everyone-does-it" approach. That method of handling value is, in fact, satisfactory as long as everyone else uses the same method. In the final analysis, the only real measure of value is a comparison, on the basis of functions provided versus cost, With the same functions and costs of competition.

However, when competition takes a different approach and provides better value, the traditional system is no longer satisfactory. The situation parallels that which has taken place in accounting practice through a certain development in the past few decades. Not long ago, it was normal practice to expect the book keeping and accounting staff of a company to be sufficiently informed to prepare any necessary reports for income taxes or any other purpose. As the years went by and tax matters assumed more importance, it was recognized that the amount of tax experience and knowledge a good accountant could have in addition to keeping up with his other fields of endeavor differed widely from the penetration of knowledge required by a tax specialism a man who dealt with tax matters every day of the year. This caused a change in thinking. It became recognized that the well-informed general accountant could not possibly know enough about tax matters to identify even a reasonable amount of unnecessary taxes and that the extra expense to the company of making it "everybody's business" to know all the intricacies of tax matters warn prohibitive. The management situation and the management attitude changed. It became standard practice to expect from regular accountants a basic understanding of tax law and practice but to utilize tax specialists and consultants, specially trained and experienced in income tax practice to identify important amounts of unnecessary tax at the proper time and to the proper extent.

Likewise, in a number of the fields of performance engineering, it is well recognized that it would be both inefficient from a viewpoint of cost and ineffective from a viewpoint of performance to undertake to teach every

engineer all of the knowledge necessary to advance design work in areas where, for example, extra-high-temperature metals are required or high efficiency of heat transfer is needed. Hence, specialists who have a depth of penetration of knowledge and experience in those areas are called in at the right time and to the right extent in order to provide information which will bring better decisions and achieve better performance.

Thus industry is learning that there is a vast difference between the everyone-does-it result and the result which is achieved by specially trained men using an appropriate set of techniques and a specialized universe of knowledge. And so managements of competitive businesses in which value is important are learning that it is efficient to provide value consultation to aid their decision makers at the right times and to the right extent.

It is not the intention in this chapter to suggest that the use of value techniques is exclusively a matter for full-time specialists. That would be like taking the stand that all sections on tax accounting should be removed from textbooks on general accounting. It is rather the intent to point out clearly that while much can be gained in achieving good value by everyday use of certain of the value analysis techniques large amounts of unnecessary cost will still be unidentified. Further, if value really is important to the business, the benefits from value activities must be enhanced by the use of specialized skill and knowledge.

Obviously, the prevailing philosophy of management and the size and scope of the particular business will determine the appropriate provision for value analysis effort. Hence the discussion which follows merely outlines basic patterns that should help to orient the reader.

8.2 SMALLEST AND SMALLER BUSINESSES

It is useful to understand clearly that while in the smaller businesses organization is not a problem, the lack of large expenditures of the hardware and process type obscures opportunity. To accomplish important results, a clear focus *on* the fundamentals of all business-even the smallest business-is necessary.

What is money spent for?

1. What precisely is the performance or service or benefit which is to come to the business as a result of the expenditure?
2. What is the value of that performance or service or benefit?
3. What are the alternative ways of securing the same performance or service or benefit and what are the associated costs?

4. The value then becomes the lowest-cost alternative which win reliably accomplish it.
5. Regardless of the size of business, the number and status of Individuals involved, the type of business, and the type of alternative, whenever change is involved there will be resistance at every step.
6. Typical of the non-product type of expense, i.e., items for which money is spent, are the following:

Paper work: Precisely what necessary function or service does each item of expenditure serve? What are the alternatives and their costs?

People's time: Precisely what necessary function or service does each item of expenditure serve? What are the alternatives and their costs?

Maintenance: Precisely what necessary function or service does each item of expenditure buy? What are the alternatives and their costs?

In businesses of below $200,000 sales per year, the owner or manager will benefit from his business very profitably by securing training in value techniques. In businesses of $200,000 to $2 million, one competent and dependable man from among the top three is usually given training in value techniques. This man will himself evaluate functions, services, and benefits secured in important expenditure areas. He will promote suitable group work and action in appropriate areas. He will constantly teach the functional approach and lead activities which bring benefits from it.

Depending upon the size and nature of the business and the emphasis at the time, he will devote more or less of his attention to this responsibility and activity.

8.2.1 One-man Setup

Businesses with $2 million or more of annual sales will start with one or more carefully selected and trained value consultants. The selection of personnel for the one-man setup is most important. This man must rank high in competence, must have a proven record of accomplishment, and must be respected by his peers and management alike. His background must exceedingly broad. The qualifications set forth in this book are a *must* for him.

Even so, it must be recognized by management that, since he will be constantly calling for change, it will be a most frustrating job. Experience shows that when one good man works in an atmosphere of frustration long enough, he often decides that it is not worth it and asks for reassignment to more traditional work which will make him more acceptable to his associates.

Real attention must be given by management to this new work until it becomes understood by, integrated into, and accepted by every phase of the business.

8.2.2 Two-man Setup

Two men can provide a much more satisfactory penetration of the necessary knowledge and experience, Combined in the two, if the work is product oriented, should have skill in (1) engineering ideas,(2) manufacturing methods and processes, and (3) the very extensive field of using vendor and specialty-vendor competence. While the two men work together, they do not work as an interlaced team. Rather, they work as consultants to each other on any particular job. In every instance, each project or activity is the responsibility of one of the two. That individual, in turn, to the right extent and at the right time, consults with the other man on the job. One of the two may be the senior man and carry certain responsibility for assigning work to the other. Care must be taken, however, that neither of the two works as an assistant to the other but rather that each accepts responsibility for a particular activity in the plant and consults with the other as needed.

8.2.3 Three-man Setup

Normally and practically, three men constitute the smallest efficient operating unit for wide-range value work. It is then usually possible to have the necessary penetration in the three required areas of skill named above. The three men again act as individual value consultants, each taking responsibility for particular value work and calling on the others as consultants to improve the degree of accomplishment again, one man may be a senior member who organizes and assigns work to the others, or else the three may report to one and the same manager who, in that case, must have a real grasp of value work, its problems, and its opportunities, and must be capable of performing the management function skillfully. Three men often aid one another during the creative phases of their work studies, and having enough in common, they do not readily become frustrated and discouraged.

8.2.4 Four or More Consultants

As the business begins to see the benefit of the activity, additional value consultants will be added. This will provide more penetration in the three identified areas, and besides, additional abilities will be secured. For example, with groups of four persons or more, an individual who has special abilities in teaching and communicating will be very valuable in that education is an

important part of the work of value consultants and specialists.

With four or more individuals assigned to the value work, it will be of definite advantage to have the managerial functions delegated to one of them. He, then, will be the one to set objectives establish plans and programs.

Provide for proper staffing of the group, augmented by provisions for continued development and growth in the individuals' competence.

Motivate appropriately

Support each specialist in his work with other segments of the business.

Administer work assignments, schedules, compensation, facilities, etc.

Structuring

In setting up a specific value work activity, first attention must be given to how this work fits into the overall organization of the business. The objectives to keep in mind here are:

1. Accomplishing the value work in the most efficient manner
2. Securing the fullest support of the effort Constantly improving the competence in execution
3. Coming continuously into prompt contact with those vital areas of the business in which the best contributions can be made.

Value work begins in the sales function of the business and continues into, and through, design engineering, manufacturing engineering, purchasing, and production. It is important to note that here sales is at the beginning instead of the end of the series. This is so because it is normally the responsibility of the sales department to determine what products and functions the customer wants. Hence the product cycle starts, in effect, with the sales activity.

Since specific actions must be taken in each of these areas in the development of the product, it follows that certain benefits are secured and certain risks must be accepted if the activity is made to report to any one of them.

Unlike the tax consultant who will clearly report to the accounting manager or the high-temperature-metals consultant who will clearly report to the engineering manager because the respective contributions of these specialists fall within specific functions, the value specialist's point of reporting in the organization is not precisely defined since his contributions go into all areas.

The benefits of having the reporting point in the sales area are that the

value consultants, through close contact with sales and marketing- planning people, get to know early in the cycle the functions desired and the approximate price for which the functions will probably sell on the market. Thus they become especially well conditioned to study these functions, evaluate them, establish value alternatives, and help carry on proper value activities throughout the business for maximum contributions to the excellence of the final product. On the other hand, as the reader will readily see, a drawback exists in that the value specialist's work will suffer because these people are so far removed from a depth of knowledge of such things as who the specialty vendors are and where specialized skills are available from vendors.

Similarly, if the reporting point is engineering, the value personnel are likely to be too closely identified with the engineering phase *of* the product cycle. Although it will bring great benefits by clearly identifying and evaluating functions and by providing value alternatives, experience shows that they tend to become more and more like engineers. Their penetration of knowledge in the vendor field and of specialized products and specialized skills, especially outside the company, becomes arrested to the detriment of their competence as value consultants.

Further, if the materials procurement or the purchasing area is the reporting point, great benefits are derived because the value specialists are in constant and normal contact with the almost unbelievable supply of functional products, functional ideas, and specialized skills that the vendor area offers. However, they are now isolated in some degree from what is going on in sales, engineering, and, to an extent, manufacturing, and much care must be taken to avoid losing a balance in competence and developing skill only in the vendor field.

When the reporting point lies in any of the above segments of the business, it has been found necessary to provide periodic and arbitrary pressure, measurement, emphasis, and motivation to make sure that both a balanced activity and a balanced growth in all necessary areas continue.

Effective long-range organization for proper value is most likely to result when the activity is cultured into the area of the business that is accountable for earnings and profits.

8.3 The Company President's Quotation

The president, general manager or project manager may be the lowest level man who must have accountability for value, yet decisions that can either halve or double profits are made without his knowledge.

Engineering management may believe manufacturing is inefficient. Manufacturing management may believe that design is too costly to manufacture. Marketing management may believe that selling work is efficient but product costs are too high.

Lack of value is possibly the only major problem for which accountability below the general manager level is unfixed. By contrast, the responsibility for other aspects of the product is clear-cut

If performance is not suitable, it's engineering;

If quantities are wrong, it's manufacturing;

If inventories are too high, it's materials;

If customers don't buy, it's marketing;

But, if value is poor, it may be poor engineering, poor manufacturing, poor purchasing, poor product planning and poor management.

Poor work results of any business function adversely affect value. As contrasted poor work results of many work functions do not necessarily adversely affect performance of the product. A product with limited engineering may accomplish its functions reliably. The only sure casualty will be value.

A poorly manufactured product, i.e., one made in slow, inefficient machines, may accomplish its function reliably, and, if enough machines are running, quantities will be correct. The only sure casualty again will be value.

A product including purchased elements "bought" in a clerical fashion may accomplish its function reliably. The only sure casualty will be value.

The direct and full purpose of all value work is to improve earnings and profits by making it possible both to sell adequate volume in competition and to have costs lie sufficiently below the selling price. Therefore, understanding, emphasis, and support flow normally from a management area which is accountable for earnings.

A well-organized business will have definite plans reaching at least five years ahead and will be implementing those plans. Some of these will involve new products or improved performance of existing ones, others will involve expanded manufacturing capacities, and still others will involve increased ability

for sales. The first plan is the primary responsibility of the engineering department, the second that of the manufacturing department, the third that of the sales department. To the extent that there are definite plans for identifying and minimizing unnecessary costs to provide increased earnings and definite implementation of these plans by a suitable number of people with direct skills in the area of increasing earnings, this important objective is likely to be secured.

8.4 INTEGRATION OF RESEARCH AND DEVELOPMENT WITH EMPHASIS ON MILITARY CONTRACTS

Benefits from Available Knowledge Sooner

Most research work is goal oriented. The purpose is either to learn new truths of nature or to combine and extend what is known in a certain manner to accomplish a specific purpose. In either case, there are problems to solve. The disciplined thinking processes of the problem-solving system are being used to accelerate good solutions to problems in which, not cost, but some other parameter is the basic need. As one manager of rather "pure" research put it, "We are quite accustomed to the practice of buying knowledge (through consultants) which we do not have in- house, but it was a new approach to us to buy the ability to get more benefit from the knowledge which we have,"

Check Your Progress

1. What are the fundamental areas of focus on business?
2. **What is one-man setup?**

Whenever cost of the research work, cost of the end product, or time to achieve a research objective is of prime importance, the procedures of value engineering are especially productive.

A top challenge to everyone engaged in work on products for the military agencies is making research and development work yield products of required performance in sufficient quantities. This is a difficult task, but it is also a fascinating opportunity promising very high rewards

It is the purpose of the following discussion to help the reader recognize his opportunities to make contributions toward significant advances in dealing with this problem,

Some very pertinent questions here are;

To what extent does the present output of research and development result in products which can be economically manufactured in large quantities needed for the available expenditure?

Can this extent be drastically improved?

If so, what are some of the steps to take in going about the task? Will not the research and development period be prolonged?

For the moment, research and development work which has as its objective the important job of producing lower costs for weapons which already have satisfactory performance capabilities, will be bypassed. Instead, consideration will be given to the greater challenge of applying value engineering techniques to research and development work concerned with providing weapons of new capabilities desirable from new technologies and to doing so in a minimum of time.

Decision Criteria-Performance and Time

The matter of securing better problem solutions depends, first of all, upon providing a clear and exact view of the problems. In research and development work, two factors are commonly given overwhelming and overpowering status and emphasis: performance and time.

Decision Criteria-Performance, Time, and Cost

In order to meet the challenge of providing adequate new weapons, three factors must receive equivalent emphasis: performance, time, and cost (quantity capability).

Understanding the Research and Development Problem

Certain basic factors seem to decree the creation of designs and specifications which are suited to single- or small-lot manufacture. In making test samples in lots of one or two, processes which will produce such samples at minimum time and cost, with minimum tooling, and with minimum search into outside special production technology are quite naturally used. For example, weldments, sand castings, specially made machine parts, and the like are often unquestionably best for quickly constructing experimental models, but they are often decidedly the worst solutions for economical production later.

It is natural that this fact tends to be overlooked by the people whose prime obligation is to jet their mental creations into hardware, to test them against natural law, and to press harder into the fringe of human knowledge as quickly as possible. Technical people in this type of activity do not at any time intentionally use a material or process which is more costly than another which they feel confident will accomplish the function as well. As they press their objective of expanding performance capabilities, they turn in each case to the most economical combinations coming within their sphere of knowledge and confidence. And when a design is tested and proven, they feel that it represents, in general, the lowest reasonably achievable cost and that performance results would be retarded if they were to accept the additional design criterion of cost.

Two factors make the problem even more complex.

First, at this stage of the development, with a design proven and tested, time has usually run out, so the only acceptable procedure seems to be to go into the market to buy, however fantastically costly this may be, these "near bread board" designs with all their complexity, with all the design experience based upon the single *or* small quantities made during development, and with attendant loss of reliability in operation.

Second, manufacturing engineers delegated the job of producing the design-in quantities are extremely reluctant to change even small details of a proven design for the purpose of making large reductions in cost. Their only safe course is to make it like the proven design and specifications and to perhaps limit suggestions to only relatively minor deviations. This plan is extensively followed.

On the foregoing bases, it appears that to bleed in the skills of quantity manufacture by searching out the best technology, materials, processes, and manufacturing procedures during the research and development stage would prolong development and that by doing so just prior to his first production order, the contractor would subject his organization to delays, uncertainties, and possible losses which it is beyond the realm of reason for him to accept.

Unless a new approach is found, all of the above considerations make it appear that in critical military work it is necessary to continue to force through the research and development on a time and performance basis, to proceed to buy the first production lot or two, and then, perhaps with established experience and with some of the particular weapons on hand, to go after the job of applying the value techniques in order to provide simpler, more reliable weapons for, say, one-half to one-third the cost.

This will be at a time when drawings and specifications are complete, spare parts lists have been prepared, spare parts are in stock, all of the tooling has been paid for, and instruction books have been written and when, not unlikely, the weapon is obsolete.

The obvious conclusion from this review of the situation is that it be hooves government and industry to provide a better answer.

Research and Development Problem Justin

In essence, the problem is how to add work to accomplish the new objective of attaining better cost value and, at the same time, promote the established objectives with respect to performance and time. Competence in

NOTES

value technology is injected to work along with other needed competence at all stages of the research and development.

The value engineering techniques being specifically developed out of day-to-day encounters with constant roadblocks represent means for breaking through these roadblocks, whether they be joint better costs or better performance. Actually, experience has shown that as much as 25 per cent can be cut from expected research and development time when challenging cost objectives have been added to previous performance objectives and when value technology has been brought into play along with the cost objective.

Commonly in research and development work, 95 to 98 per cent of them falls in areas of technology, and 90 per cent or more of product cost is ascribable to the provision of known functions. Often it is desired to provide these functions in the new product in a manner which make them simpler, more reliable, smaller in size, or lower in weight, i.e., with qualities which are normal direct result of the use of the value technology.

Better Research and Development

***Answer* Sooner**

Illustrations by the score are to be found in military work areas. Study of some of them will provide the reader with guidance in establishing the *use* of value technology in his research and elopement activities.

An example, documented by the Navy in a film available for showing to qualified groups, is the audit of Ships' application of after-the-fact value engineering to a procurement of 1,000 landing : One included item was a 200-gallon gasoline tank which was completely drawn and specified requirements like very costly metal, much custom welding, and other cost-consuming factors. It was quoted as $520 each, $520,000 for the lot.

As the value technology was applied, the function of reliably containing 200 gallons of gasoline evaluated at approximately $50. The result was that four 55-gallon steel drums, treated for the other environmental conditions, were used at a cost of $80 each or $80,000 for the procurement.

8.5 PRACTICAL ORGANIZATION FOR SECURING BOTH VALUE AND PERFORMANCE OBJECTIVES

In retrospect, it can be seen that if the value technology had been available and had been used during original research and development on the product, it would have been totally unnecessary to design and draw up the tank and to

prepare specifications on the welding, testing, etc. Instead, standard steel drums treated with available environmental finishes would have been specified, probably on one 8 X 11-inch page, with no design work and no drawing preparation. Engineering time would have been conserved and devoted to the acceleration of other research and development work on the craft, with the end result of shortening the time for the total project.

It follows that better solutions are attainable sooner by:

I. Utilizing the value techniques to overcome stoppers against either, improved performance objectives *or improved* cost objectives.

2. Expanding the technological competence addressed to both the performance aspects and the value aspects of the product throughout the development by drawing upon the huge supply of top-grade knowledge, technology, and creativity which exists in diverse government and industrial circles. Organizing for the task of bringing good alternative solutions into clear focus in a minimum of time and with the utilization of best know-how wherever it exists is a part of executing sound value engineering.

In these ways, the research and development process for better means of accomplishing functions becomes substantially one of blending together the twin needs of extending the range of performance on the one hand and lowering the cost on the other. Technology oriented toward the performance field will be utilized to the fullest, while at the same time; equal competence in people trained in the techniques for accomplishing functions at lowest cost will be working hand in hand to produce more reliable, lower cost (higher quantity) research and development work in less time.

It would be gross over simplification to contend that the suggested change in approach is an easy one to bring about. The conflict with past human concepts, thoughts, behaviour, and procedure is too great. However, it seems indisputable that the day is here when the technologies for obtaining very much better cost must take their place beside the technologies for obtaining better performance. Only in this way will each weapon have quantity capabilities as well as performance capabilities.

It is clear that the task of value analysis people is to assure that in every part of the business actions are accomplished that will allow the achievement of competitive costs. Often, in normal operation of good business, decisions and actions that seem quite proper are taken in one company area, such as management, sales, or engineering, and do indeed produce no extra costs there.

However, they may and often do cause large amounts of unnecessary costs to develop in manufacturing, procurement, or elsewhere.

Experience has been gained with the value analysis group reporting to sales, engineering, manufacturing, procurement, accounting, and general management. Reporting to each has certain advantages, and reporting to the first five has a common disadvantage. In order to operate successfully and assure the business of proper costs of present and new lines alike, work must be done in, with, and for each of the decision making areas named. The tendency is to develop the habit of doing much more thorough work in the area of reporting, using an important amount of time in so doing, while leaving other business areas without the assistance required to secure assured overall company results.

Often, after need becomes overcritical and assured results are essential, reporting is done to the man accountable in measured terms for earnings. This has proved very effective.

Job of the VE Consultant

The principal work content of the VE consultant falls into four basic classes:

1. Integration
2. Value appraisal and product evaluation
3. Value consultation
4. Value training

A suitable proportion of work from each of these classes must be achieved in each of the product-cycle stages, beginning in sales and progressing through engineering, manufacturing engineering, purchasing, and production.

Indoctrination of Management

Allied to the training of the "doers," along the lines discussed in the following paragraphs, is the matter of indoctrinating management. A full comprehension by management at all levels of the aims and workings of value analysis is a prerequisite to the attainment of the fullest measure of benefit from coordinated value activity. It falls within the scope of the work content of the value consultant to arrange and conduct indoctrination sessions as the conditions may warrant. Well-proportioned attention to this phase of cultivation invariably brings substantial payoff both to the company and to the individual. Management understanding, confidence, and active support are essential to high achievement.

Integration

It is normal human nature to discredit that which we do not understand. Thus, if a new system appears in the industrial or other business setup, it will be subject to suspicion, doubt, discredit, and disfavour by all who do not understand it. It is self-evident; therefore, that what comes first is to integrate the work into the activities of every individual in the work area. Each person must know what the work of this new activity is; how it will be done; how it will affect him; in what respects it will make his work more difficult or simpler; what benefits that he has been getting he will now have to divide with value personnel; that this activity is not the boss's "pet" brought in under disguise for a period of time and later to be changed into something that will affect him badly.

The responsibility for answering all these questions before they have had time to arise to any significant extent becomes the first part of the work content of newly established value consultants.

Experience proves that it is a safe rule to devote as much as half of the entire resources for a period of many months to correctly accomplish this part of the work. Obviously, as understanding grows, the time devoted to it diminishes. However, with new situations continually developing and new people often coming in, care must be taken not to overlook this part of the work even in a going operation. It must be clearly understood that the purpose of the value consultants is to assist each individual who makes decisions affecting value to have at hand more information at the time of decision making so that he will make better, decisions. Unless this is well known and unless working understandings are developed which include all of the relations, the results of the value activity will be greatly diminished.

8.6 VALUE APPRAISAL AND PRODUCT OR SERVICE EVALUATION

This is after-the-fact value work. It consists in starting with the product, or process, in its present form, studying its functions intensely, applying the value analysis techniques and special knowledge, and producing improved value alternatives which are then presented, in suitable form to the decision-making people involved. This is probably the part of the activity which is best known and which is most apt to be overdone.

It is very important to periodically provide a value appraisal for typical products and services of a particular area. This not only brings possibilities for

greatly improved value of the specific item but also serves as a measurement of the degree of value work which is being effectuated on other, unstudied products. Results in this class of value analysis activity are limited in that it represents after-the-fact work. Often the outcome is embarrassing to the people who had to make operating decisions at an earlier stage, perhaps when they had important performance problems to solve and were possibly short of time and help. Work in this area brings much antagonism unless it is handled with extreme care. Besides, changes here are more costly and often more slowly made because drawings have been made, instruction books have been printed, replacement parts have been standardized, etc.

Nevertheless, sight must not be lost of the tremendous benefit to increased earnings which may come from doing a proper amount of work in this direction. As one engineering manager said, "When a product is designed, the entire field is at risk, and lacking time to make minute studies of every detail, all decisions must be made on the safe side even though it is well known that some of them are locking into the product considerable excess cost." After the product is in operation and has proved itself, work can then proceed on studying these various phases of the product one at a time. Unnecessary cost should be identified and should be made subject to removal as promptly as practicable.

Experience has shown that much more satisfactory results are accomplished if value consultants study products of this class on the invitation of whichever department - sales, engineering, manufacturing, or purchasing - is involved in the later decision making. When thus invited in, their findings are sought and do not come as an embarrassment to the original decision makers.

Value Consultation

It is, of course, normally very much more desirable, and in actuality very practical, to provide value alternatives before the fact. This results from consultation, a direct parallel to the work performed by the tax consultant. Sales, engineering, manufacturing, or other people, faced with a product to design and produce or with a manufacturing system to develop or with a function to evaluate, quite naturally invite value consultants to make their contributions.

The process starts, then, by learning thoroughly the functions needed. This can be done almost as well from a drawing or specification as from a model. Next the consultants proceed to apply the value analysis techniques

and special knowledge to establish the values of these functions and provide tangible information on value alternatives. The information thus derived is used by the decision makers in their original decisions so that the product will have the intended performance or features and will offer a better degree of value as well. As value people have worked successfully along this line in an operation, they have been accepted, and more and more of their time have been requested for before-the-fact consultation work.

Value Training

An important segment of the work content lies in constantly training substantially all individuals in the business to recognize and use certain of the value analysis concepts and techniques which they need and can take in stride in their daily work. In some cases, it is also desirable to provide training which will provide for replacements in the full-time professional value work.

Experience has proved that many of the value analysis techniques are useful not only for the purpose of helping sales, engineering, manufacturing, and purchasing people to secure better value while they execute their other essential assignments, but also, in many cases, for enabling these people to better accomplish their basic assignments.

The value analysis techniques are means for recognizing what is basic in the product or service, i.e., what the required functions are. They are also means for efficiently developing alternative

answers which often will provide better quality, increased performance, lighter weight, improved appearance, and other added values to the product in addition to lower cost.

As a consequence, it is obviously desirable to establish courses to provide basic value analysis training to substantially all design engineers, draftsmen, manufacturing engineers, methods experts, production leaders, materials specialists, buyers, and others whose decisions affect the value of the product.

From practice it has appeared that training of people throughout the business environment will produce about half of the gain which can be accomplished by the effective use of the value analysis techniques and special knowledge. These people then take the work in stride, and it, improves their value on the job. It also improves their yield to the company as well as their own job satisfaction. It is therefore important that value consultants recognize this area of responsibility and opportunity and effectively organize appropriate training.

As to the amount of training, this will vary with the individual, the individual's work, and the prevailing situation. Between forty and eighty hours of combined training and "do-it" work for each of these people is likely to result in substantial accomplishment. One afternoon of training each week for ten to twenty weeks is a good plan.

The training should consist of indoctrination in the value analysis techniques and in the special knowledge, concurrent with the study of actual products from an area which provides opportunity for the application of the techniques. It will include suitable contact with experts from outside the specific area whose knowledge penetration is of vital concern to the trainees in providing better answers to the projects under study. It will also include dealing with representatives of vendors of available specialty functional products to make the learners realize that large numbers of functions can be readily accomplished by using what already exists on the market, usually at the most economical cost.

Check Your Progress

3. What are the benefits available from knowledge sooner?
4. What is integration VE process?
5. Explain briefly Value Training.

It is apparent that when others in the business environment have had this basic training the task of integration is practically completed. In consequence, the consultants will be called upon to make their contribution to value at the right time, before decisions are made, and much more challenging value objectives for the business can be reached in a straightforward manner.

8.7 SUMMARY

Suitable organization for the attainment of the best benefits of value analysis will be assessed first from a viewpoint of the overall business, second from the viewpoint of the men performing the work, and third from the viewpoint of the relationship between the men doing the work and the management of the business. when competition takes a different approach and provides better value, the traditional system is no longer satisfactory. It is useful to understand clearly that while in the smaller businesses organization is not a problem, the lack of large expenditures of the hardware and process type obscures opportunity. The president, general manager or project manager may be the lowest level man who must have accountability for value, yet decisions that can either halve or double profits are made without his knowledge. Commonly in research and development work, 95 to 98 per cent of them falls in areas of technology, and 90 per cent or more of product cost is ascribable to the provision of known functions. Often it is desired to provide these functions in the new product in a manner which make them simpler,

more reliable, smaller in size, or lower in weight, i.e., with qualities which are normal direct result of the use of the value technology.

It is very important to periodically provide a value appraisal for typical products and services of a particular area. This not only brings possibilities for greatly improved value of the specific item but also serves as a measurement of the degree of value work which is being effectuated on other, unstudied products. Results in this class of value analysis activity are limited in that it represents after-the-fact work

8.8 ANSWER TO CHECK YOUR PROGRESS

1. What are the fundamental areas of focus on business?
   - What precisely is the performance or service or benefit which is to come to the business as a result of the expenditure?
   - What is the value of that performance or service or benefit?
   - What are the alternative ways of securing the same performance or service or benefit and what are the associated costs?
2. What is one-man setup?

   Businesses with $2 million or more of annual sales will start with one or more carefully selected and trained value consultants. The selection of personnel for the one-man setup is most important. This man must rank high in competence, must have a proven record of accomplishment, and must be respected by his peers and management alike. His background must exceedingly broad. The qualifications set forth in this book are a must for him.
3. What are the benefits available from knowledge sooner?

   These are: To what extent does the present output of research and development result in products which can be economically manufactured in large quantities needed for the available expenditure?

   Can this extent be drastically improved?

   If so, what are some of the steps to take in going about the task? Will not the research and development period be prolonged?
4. What is integration VE process?

   It is normal human nature to discredit that which we do not understand. Thus, if a new system appears in the industrial or other business setup, it will be subject to suspicion, doubt, discredit, and disfavor by all who do not understand it. It is self-evident; therefore, that what comes first is to integrate

the work into the activities of every individual in the work area. Each person must know what the work of this new activity is; how it will be done; how it will affect him; in what respects it will make his work more difficult or simpler; what benefits that he has been getting he will now have to divide with value personnel; that this activity is not the boss's "pet" brought in under disguise for a period of time and later to be changed into something that will affect him badly.

5. Explain briefly Value Training

An important segment of the work content lies in constantly training substantially all individuals in the business to recognize, and use certain of the value analysis concepts and techniques which they need and can take in stride in their daily work. In some cases, it is also desirable to provide training which will provide for replacements in the full-time professional value work. Experience has proved that many of the value analysis techniques are useful not only for the purpose of helping sales, engineering, manufacturing, and purchasing people to secure better value while they execute their other essential assignments, but also, in many cases, for enabling these people to better accomplish their basic assignments.

TRAINING FOR VALUE ENGINEERING

9.1 INTRODUCTION

Successful accomplishment of some types of work requires logic and experience. Examples are the work of the plumber and the electrician. Other types of work require logic and experience supplemented by the development of certain skills. Examples are the work of the surgeon, the typist, the telegraph operator, and others. Then there are types of work whose successful accomplishment ends on experience and extreme creativity. Examples are certain types of art and some types of music production. Probably most other types of work activity fall in the range between these extremes.

As wider experience is gained, the specific qualifications for the relatively new vocation of value specialist or consultant will become more clear, more tangible, and more reliable. The indications of experience to date are that for the successful accomplishment of value work, the requirements are logic, experience, and great creativity, plus the development of certain mental skills such as ability to:

Make rapid and effective searches

Recall

Sort out useful information from what is not useful. Put together new, different, and useful combinations of ideas, materials, products, and processes to accomplish functions. Promptly select those combinations which are most apt to be good ones.

All these abilities and skills, it will be seen, have a close tie-in with creativity and thus actually become the means through which creativity operates. It will also be noted that the special information and knowledge of value analysis operate directly to support the development and use of this skill.

Traits, Characteristics and Experience

The necessary traits, characteristics, and experience, as spelled out and defined below, constitute essential qualifications for men engaged in value work.

Knowledge

For product work, a practical understanding of the properties of materials and their uses and of manufacturing processes, their potentialities, and their limitations is needed. For service work, the equivalent knowledge in that field is necessary.

Imagination

A good practical creative imagination commonly includes ability to retain extensive amounts of information concerning ideas for approaches and solutions to product problems, types of materials, properties of materials, processes, costs, and so forth, all arranged in a suitable order so that differing combinations may be creatively brought together and examined for applicability to problems at hand.

High Degree of Initiative

In value work, there are no definite beginning and ending points, and specific instructions on how and where to proceed are usually non-existent. Further, this type of work is not well enough comprehended by general management for a rate at which it should be accomplished to be spelled out. For these reasons, it is essential that men in value work have a high degree of initiative, which must include what might be called self drive so that work activities will be started and carried through with little supervision, if any.

Self-organization

Initiative and drive are not enough; work must be effectively organized. Because of the lack of precedent and the lack of knowledge of organization for value work, conventional management supervision provides no experience for effectively instituting and executing the work. Therefore, the dividable doing the work requires the ability to organize his activity effectively, as well as enough iterative to carry it out.

Personality

The work requires a mature, stable personality which is not easily discouraged. The entire activity in value work comes within the area of change. The amount of opposition to change ally prevailing can not be conceived by anyone who has not attempted to operate in this area. Individual doing value work will be confronted with negative attitudes and delays of all sorts, belittlement, and even with ridicule. The basic nature of anything new and the inherent attitude if the people with whom he will be dealing decree this. As Charles Kettering said, "The consensus *in* any group of people concerning something new in their field is always wrong." Or, as Thomas |Edison said in 1926, "It requires about seven years for the average individual to accept a new proven solution to a problem." Because of this very exhausting aspect of value work, it is strongly recommended that it be performed by two or more persons working together. Each can then have an emotional environment of support, at least part of the time, which helps him feel that his work is satisfactory and worthwhile endevour.

Cooperative Attitude

A desire to work with others and a general knowledge of how to do it are other requirements, since the work is largely an endevour based on working with others. It begins with acquiring an understanding of the job and proceeds by developing information which is often not available in ready form but which must be obtained if good value alternatives are to be produced. Knowledge concerning desired functions and methods for accomplishing them must be collected. Significant information must be communicated to competent commercial and technical people, and their wholehearted support (often with quotations) must be enlisted in expanding the area of knowledge in the direction of their skills through the preparation of value alternatives. In many instances, the work includes the difficult assignment of getting information without giving offense.

Experience

All indications to date suggest that some five years of industrial experience in engineering, in manufacturing, or in special procurement dealing with particular specifications, opportunities, arrangements, and negotiations between buyer and seller (or equivalent experience) is essential. It seems also that actual experience in working with the normal situations that affect the development of value alternatives is required. These situations involve decisions between varying ways of accomplishing a function, between varying sources of supply,

between differing systems of make versus buy, etc. Without experience along this line, there is a lack of background for efficient and effective search of possible combinations and for presentation of new and good value alternatives.

Belief in the Importance of Value

Starting with certain native inclinations and modified by childhood and business experience, any person develops interest in certain lines and disinterest in others. Essentially in all cases, human beings are interested in food, although in some cases of unusually unfortunate environments, even loss of interest in food is developed by people. Some individuals are interested in flying, while others vow that they will resist it to the death. Similarly, some people develop an interest in providing new products through the development of new functions which their ingenuity can translate into a practical product. Other individuals develop an interest in making products more economical so that distribution may be widened with resultant benefits, not only to the company involved in selling the products, but to mankind in general, through more universal use. At the present stage of experience with value work, it appears that there exist marked degrees of difference in the beliefs of various individuals in the importance of low cost or its equivalent, high value-in the general sense. Experience has shown that men who have strong belief in the importance of value are much more likely to be sufficiently motivated to develop the initiative, self-drive, and enthusiasm necessary to accomplish their work well. Such strong belief also seems to be an **important factor in creating** emotional stability in this very frustrating type of work. Hence the conclusion that "belief in the importance of value" is a significant trait.

9.2 AN UNDERSTANDING OF THE MANAGEMENT AND DECISION PROCESS

It is also important to have a reasonable comprehension of the management and decision process. A host of good books provide this knowledge in depth. Management processes are not always optimum. For years, up to and including the present, decisions have not always been the best ones, but they are very real and very "controlling." Removing unnecessary costs often means patient, persistent, effective work for improvement in these areas.

Training

Five Essentials of Training

With the following training essentials, men will be prepared with understanding, with procedures and the experience of using them in disciplined

thinking and acting, and with the confidence that grows only from a self-done task

1. It must allow and cause each trainee to develop his own disciplined thinking.
2. It must provide understanding of reasons for excess costs.
3. It must provide disciplined procedures for identification and removal of unnecessary costs.
4. It must provide some new knowledge and much technique to be used in determining what knowledge to get, how to get it, and how to use it.
5. It must cause and allow each man to actually use the system and to secure better results than he thought he could.

How Much Training?

One week of training followed by six months of good on-the-job value work (preferably with other trained and experienced men), another week of training of a more advanced nature, often including the teaching of beginners), and then six months of additional value work are good.

A general conclusion is that with this year of alternating between on-the-job work and periods of training, men who have the proper characteristics, qualifications, and traits for the type of work involved can acquire a sufficient degree of knowledge and skill to be considered competent to start on a career of work as value consultants.

It is significant to understand that training is mandatory because value of work is based on the use of different sets of techniques in a special way and on the use of special knowledge. Without suitable training, the quality of the value work will degrade the profession for those competent qualified people who can accomplish results of the highest order.

An Effective 40-hour Training Seminar

Sessions can run continuously for a week or can be spaced.

Hours 1 to 4:

Why the training?

What are we trying to do?

What is the value analysis and engineering system?

Why is the value analysis and engineering system needed?

Case studies

The vitalness of the right complete system

What must the system do?

Hours 5 to 8:

All cost is for function

Case study	**30**
Identify, classify, and name the functions	30
Project work-get started, understand it	
Identify, classify, name functions of project	90

Hours 9 to 12:

Evaluate the function

Case study

Evaluate the functions of the project

Problem setting-function grouping and dividing

Case study 30 Problem setting on the project

Hours 13 to 16:

Specific knowledge

Problem setting on the project

Problem solving-job plan

Project work-"What are we trying to do?" "Information" steps on project

Hours 17 to 20:

Problem solving-job plan continued

Case study 30 Finish 'information" step and get into "analysis" step of project

Decide and precisely define what problems are to be solved

Case study

Hours 21 to 24:

Specialized knowledge

Group creativity

Creativity on project problems

More "information, analysis, and creativity" on project problems Case study

Hours 25 to 28:

Specialized knowledge

"Judgment" step of job plan

Project work-information, analysis, creative, judgment "Development" step

Hours 29 to 32:

Specialized knowledge

"Decision environment"

Case studies

Project work

Hours 33 to 36:

Using the system to solve the hard ones Overcoming road blocks Finish project work-get into shape for reporting Examples of good reporting form

Questions and answers on reporting

Hours 37 to 40:

Finalize results and suggestions and prepare charts, reports, presentations 120 Minutes

Present reports 60 Minutes

Discussion

Thus it could be concluded that Value analysis is a system for use when better than normal results are needed. It is readily understandable that before an individual can be expected to achieve better than normal results, he needs the experience that enables him to produce normal results under the usual conditions. Five years or more of experience dealing with product or service factors of similar types are usually essential.

Broad knowledge in the field, a good practical creative imagination, a high degree of initiative, the habit of good self-organization, a mature personality, a very cooperative attitude, a belief in and feeling for" the importance of low costs, and an understanding of the management decision process-all are essential for the optimum value analysis person.

An initial training period of 40 hours, of which about half is actual work, using, the system, starts the use of the techniques. Six months of experience followed by another period of training usually results in enough familiarity with the system so that the individual can develop skill in value analysis.

9.3 MOTIVATION, MEASUREMENT AND TESTS

Achievement of significant objectives in any activity requires motivation in some form or another. What constitutes appropriate motivation in the area of substantially decreased cost, and thus increased value, will be discussed next.

Motivation will be considered in four categories:

1. The business
2. Managers
3. Value consultants and others using value analysis techniques
4. Decision makers

The Business

No business has sufficient competent personnel to pursue all desirable objectives with high emphasis. The general situation in business may be linked to that faced by a baseball team, which has only nine men to cover the entire field. Depending on the score, the pitcher, the batter, and the phase of the game, these men will be placed somewhat differently and will play under instructions to put emphasis on particular, activities. Much the same occur- in business. The organization must possess an appropriate amount of competence, or else it will fail. But the men who make up this competence must vary their activities to meet the greatest pressures and thus produce results in those areas in which action is most needed. To motivate a business to organize for high value content in its products, a "force of necessity" is normally required. It must be vital to the business to accomplish value objectives in addition to performance objectives, shipment objectives, and other goals.

> ***Check Your Progress***
>
> 1. What is the use of knowledge in training?
> 2. What do you understand by cooperative attitude?
> 3. List out the five essentials of training.

A corresponding force is often created by a forward-planning management which, when it sees a threatening situation developing; proceeds to generate emphasis for effective actions to prepare the business to meet the situation when; perhaps years hence, the time arrives.

In the absence of either of these two forces, motivation is usually inadequate to cause steps to be taken to establish and execute a program which will provide for leadership in value.

Managers

Experience has shown that motivation in four forms provides satisfactory results.

NECESSITY : This may be the necessity imposed by the immediate

situation or the necessity created by forward planning by the top management of a business. Either of these forces makes it vital to efficiently identify unnecessary costs, and they dispel all doubt about the importance to the business of assigning sufficient resources to accomplish significant results in the area of value.

BOSS PRESSURE: This force must, of necessity, be clearly promoted by the managers' superiors so that there can be no question in managers' minds as to whether they should strive for significant progress in the value area or merely continue to give attention to the traditional areas to which they have been accustomed. Each manager must know that, to an important extent, he will be measured and appraised according to his accomplishment, i.e., the accomplishment of the group he manages, in this activity.

MINIMUM-PERSONAL-LOSS ENVIRONMENT: The creation of an environment for minimum personal loss is a third form of motivating force. Taking different actions in order to achieve a very much improved degree of value means doing things differently and hence brings about the ever-present risk of personal loss. To the extent that the chances of personal loss due to value action are not eliminated from the manager-boss relationship and the manager environment, important negative motivation exists. It is therefore imperative, in creating a maximum of positive motivation, to give much attention to reducing the personal-loss factor. .

COMPANY RECOGNITION OF ACCOMPLISHMENTS: Managers have traditionally been recognized for their accomplishments in areas other than that of product value. They need to be assured that, as a reward for their efforts and for the risks they take in the value area, they will receive appropriate recognition for accomplishments.

Value Consultants and Others Using Value Analysis Techniques

In developing reasonable motivation for people who are doing value work, five important methods should be kept in mind.

EMPHASIS: Enough emphasis must be placed by management on the importance of high-grade value work so that the endeavor and the time of the men engaged in it are not constantly encroached upon by ever- demanding performance problems, delivery problems, etc. That management does indeed place as much emphasis on good value as on these other, more short-range factors in the business needs underscoring.

SUPPORT: Good value work is not accomplished without a great amount

of "doing." This means men going places, studying new things, encountering problems, and being misunderstood by their co-workers in other company activities. The extent to which their new type of work gets support from management in these situations adds a very significant plus or minus factor to the motivation of the "doers."

STATUS: Anyone engaged in value work requires a status corresponding to that of others in the organization whose work is better known and hence receive more consideration from management. The man must be able to go home at the end of the day and say proudly, and with conviction, 'I am in the value activity." Again, the degree to which management provides appropriate status for the people doing this new type of work accounts for a significant plus or minus factor in motivation,

FAIR MEASUREMENT: Fair methods of measurement of performance must be established. traditional methods of measurement, which do not fit but which are familiar to others in the environment, must not be improperly used. If the man does a good job in his work of identifying unnecessary cost, will managers say, "Good work, Joe"! Or, if he does a poor job, will the managers be able to say, 'I think you can do better, Joe"? Fair effective measurement is a strong motivator.

RECOGNITION: Proper and appropriate recognition before their peers in relation to the effectiveness of the work of value consultants becomes a vital plus factor in motivation.

Decision Makers

Each decision maker has specific measured responsibilities; for instance, he may sell the product, design the product, manufacture certain quantities of specification-grade product, provide metered quantities of materials of appropriate grade to the factory, or reach certain inventory- investment objectives

EMPHASIS: In all cases, emphasis is very real and measurement is very direct. If these people are to invest important segments of their time in working out value alternatives, "debugging" them, testing them, and taking the necessary chances which always come with any change, they must interpret the emphasis on these tasks to mean that accomplishment therein is as important a part of their work as the measured part.

MINIMUM-PERSONAL-LOSS ENVIRONMENT: The reader was alerted in an earlier chapter to the importance of eliminating the personal-loss

factor if decisions to produce better value are to be expected. Experience would indicate that the motivation to produce effective results in the improvement of value by decision makers is affected by extremely large plus or minus factors according to the effectiveness with which management handles this phase.

MEASUREMENT OF ACTION AND LACK OF ACTION: Nearly every phase of human nature promotes a negative decision on the part of the decision maker. If the value alternative can be rather promptly ruled out on plausible grounds, the decision maker is then at liberty to return to his major measured field of activity without having suffered personal loss. To provide reasonable motivation for action, measurements are needed which will clearly highlight lack of action. As soon as a fair and supportable measurement of lack of action is provided and accepted, the personal-loss factor is increased by negative rather than positive actions and significant increases in motivation result.

UNDERSTANDING OF FAILURE: In normal activity, success does not result 100 per cent of the time. In some of the projects of studying value alternatives, making models, testing, developing new vendors, and proving new processes, results will be found to be negative. Meanwhile, an important amount of time and of money may have been spent upon the project. It is never known before this work is done whether the result will be an important accomplishment or not. It is important, therefore, that management clearly show itself ready to stand back of, support, and understand the effort when it judges alternatives that had a fair trial but did not work out.

RECOGNITION OF SUCCESS: The earnings position of the company will be greatly benefited from time to time by specific activities in the area of value improvement. Important motivation will be provided and future results will be greatly enhanced if clear recognition of successes I is given.

Measurement of Organizations

The following Value Analysis Organization Study and Measurement Guide illustrate a good approach to the important problem of measuring organizations. It is meant not only to cover measurement questions but also to contain some of the significant answers for the indoctrination of management people who are performing the study and measurement.

9.4 VALUE ANALYSIS ORGANIZATION STUDY AND MEASUREMENT GUIDE

(Mark an scale of 5, 4, 3, 2, 1; 5 indicates highest merit and 1 lowest)

Areas of study:

1. How well is value analysis understood?
2. How well is the value analysis organization suited to the business involved?
3. How correctly is the value analysis operation set up?
4. How effectively are the value analysts operating?
5. Do miscellaneous factors aid the value analysis operation?

1.How well is value analysis understood?

How well is it understood by:

Top management?

Intermediate management?

Engineers?

Manufacturing and methods staff members? Buyers?

Sales people?

Others?

Value analysis is a creative study of every item of cost in every service or part or material. It considers other possible materials, newer processes, abilities of specialized suppliers, and possibilities for engineering revaluation. It focuses engineering, manufacturing, and purchasing attention on one objective-equivalent performance for lower cost. Is value analysis well understood to comprise special techniques, a special system, and special knowledge, not to be just a substitute for cost reduction by: Management? Engineers?

Manufacturing people? It is not a substitute for present engineering, manufacturing, and purchasing cost-reduction work; it is a supplement. It improves the effectiveness of the work being done in those areas and, in addition, fills a blind spot. It is accomplished by carefully selected, trained full-time specialists using established techniques and following an established plan which results in eliminating all types of unnecessary costs not normally identified and eliminated by other methods.

2. How Well Is the Value Analysis Organization Suited to the Business Involved? Does it include the proper number of specialists?

Do they work full time?

Normally, value analysis specialists return from $10 to $25 to the manager for each dollar they cost.

How well are value analysts qualified by ability, experience, and training? Do they have (rate each man and average) :

a. Engineering or methods and planning experience supported by a general understanding of the properties of materials and their uses?

b. A good creative imagination?

c. Enough initiative, self-organization, and self-drive to start and complete their projects with little if any supervision?

d. A feeling of the importance of value?

e. A mature, stable personality not easily discouraged?

f. The desire to work and deal with others and general knowledge of how to do it? Have they had sufficient instruction in value analysis techniques?

How well has each learned:

a. To develop the complete facts?

b. To use a businessman's judgment?

c. To think and act creatively?

d. To use and bring in help from others?

e. To provide himself with special information?

How well is the value ability developed in each man?

As other skills are developed, we believe value ability can be developed. Value analysis training aims at that objective. Experience and proper action further develop it.

3.How correctly is the value analysis operation set up?

Do the analysts work individually with one man responsible project, instead of by committees! Do they avoid all discussions or meetings involving more than a total of three at the table at one time?

Value analysis is not committee work. It is conducted by one man intensively following a project; he may discuss particular phases with others, one or two at a time at most.

Are the value analysts expected to constantly crystallize their suggestions in the value analysis suggestion sheets?

Are the suggestion sheets clear, concise, definite, and tangible, and are they drawn in executive language?

If the value analysts report to materials management, have they established a working relationship based on 100 per cent understanding, confidence, and cooperation with engineering and manufacturing

If they report to engineering or to manufacturing engineering, have they established a working relationship based on 100 per cent understanding, confidence, and cooperation with the purchasing department and every buyer in it?.

Do they report high enough in the organization for their critical problems to be immediately known by sufficiently high authority to at once receive effective action?

To what extent is the business getting a fresh look into each job? (Men with years of experience in the area, who have gone over the same work several times, may be channeled in their thinking,

Surprisingly, men who have long worked on a project are often the least capable of eliminating further large quantities of unnecessary cost by value analysis techniques. To eliminate large quantities of unnecessary cost, such men should usually be assigned other work and "new blood" brought into the job.

4. How effectively are the value analysts operating?

How effectively have the value analysts developed "function" thinking?

Is all of their thought on function?

Value analysts relate costs to the function or service or operation purchased by that cost'

They question each specific item of cost to determine what function it really buys. For example: What is it? What does it cost per year? What does it do? What else would do the job and what would that cost? Then, each dollar of cost which does not clearly buy definite function is strongly questioned. Function is simply defined as something that makes the product work better or sell better.

Do they actually get all of the available facts before starting work?

Drawings and specifications that are available

Planning cards when they exist

All costs when they exist

Samples of parts when they exist

Assembly in which parts go when such information exists

When starting a job, do they always learn the basic engineering?

Do they always learn the basic manufacturing?

Have they learned to listen and to make absolutely no suggestions at this stage?

Do they avoid going back to engineering and others and making incomplete suggestions?

Are they using the value analysis job plan in all its steps?

Mind setting (Exactly what are we trying to do?)

Information

Analysis

Creativity

Judgment

Development planning

Value analysis work follows the value analysis job plan in which the analyst intensively seeks out, adapts, evaluates, and applies.

Do the value analysts "blast" in attempting to initiate long-term gain or large-percentage gain of at least 50 to 90 per cent cost reduction in fields of Administration, Manufacturing methods, Purchasing?

Do they also strive for reductions of 50 per cent down to 10 per cent?

Value analysts both blast and refine. A portion of their time is invested in searching for means of accomplishing the same job for one-tenth or one-fifth or one-half of the cost. The remainder of their study consists of effort to refine, with reductions more nearly in the area of 40, 30 or 20 per cent. It is often easier to remove 50 per cent of the cost than 10 per cent.

Does the managers' representative promptly refer proposals to the proper managers for their assignment?

Do about 80 per cent of suggestions develop into substantial savings? Do the analysts get right out into the vendors' plants to learn?

Does this activity take analysts out into other plants about one day on the average in every two weeks?

Have any deterring factors which would retard results been avoided, such as the necessity to ask permission of someone who does not understand the details of the need?

Do the analysts use all means of immediate and effective action such as : Immediate personal contact through trips or planned conferences? Telephone? Telegraph?

In searching for methods of value improvement, does the analyst have free reign to initiate studies which take him into the area of :

Administration?

Engineering?

Make-it or buy-it?

Proper ordering quantities?

Better inventory control?

All others?

All have a bearing on value. The analyst is free to develop facts in any and all areas.

Does management select about half of the analyst's projects?

Do the value analysts normally select about half of their own projects?

Value analysts should have the initiative to ferret out and identify cases of poor value. They accordingly select 50 per cent of their own jobs and normally handle, in the remainder of their time, jobs referred to them by management. An important reason for this is that, unless they do, shocking cases of poor value which could be readily corrected continue year after year because management in the particular area involved happens to be overlooking them.

Do value analysts regularly consult others - specialists in engineering, in methods, in procurement in preplanned interviews of one or two hours duration?

Do the managers assign the suggestion sheets to their appropriate subordinates, supervise them, and secure progress reports on them exactly as they do with other job assignments?

It is recognized that the managers will supervise their own men and that the men will report back only to their own bosses on the status of accomplishment or lack of it.

Is it well understood that the value analysts make no decisions?

Value analysts make no decisions but develop facts for management decisions; accordingly, while they are a large factor in such matters as make-it or buy-it," they develop the facts and management decides.

Are the men provided with suitable physical and clerical assistance so that they can invest their time effectively at their highest potential?

Adequate and suitable space for interviews, for study, etc, Clerical assistance Stenographic assistance

5. Do miscellaneous factors aid the value analysis operation?

Are all buyers trained in the value analysis techniques that pertain to buying?

Have the value analysts arranged for equipping themselves with the specific information they "will constantly need to do their job well?

Has the value analysis group assumed a position of real leadership in the department by constantly increasing the knowledge, understanding, and use of value skills through regularly planned courses or study groups?

Are the habits and attitudes which allow significant value improvement in the department progressively improving?

In management

In engineering

In manufacturing methods

In purchasing

Value analysis requires serious thought, hard study, and immediate action. In cases of doubt, it is necessary to err on the side of doing something rather than on the side of stable conservatism. Value analysis performs as an engineering and a manufacturing tool and reaches out of the company into the limitless supply of technical information.

Have the analysts learned how to work with and through the buyers, the engineers, and the manufacturing methods men, never around them? Do they always, in the long pull, strengthen each in their own field?

Do others always cooperate fully with the analyst?

In management

In engineering

In manufacturing methods

In purchasing

The job of value analysts is to get today's and tomorrow's materials, ideas, methods, and processes into use today. If they operate properly, they will use all of the resources in the entire country in this program.

9.5 MEASUREMENT OF VALUE WORK

Each of the four types of work comprising the value analyst's work should be measured separately, and in general, measurement should be both of the amount done and of the amount not done. The four types of work, the reader will recall, are integration, value appraisal, consultation, and training.

INTEGRATION:

The manager to whom value consultants or analysts report should set up with them listings of all persons on the organization who have certain important information about the plans of operation of the value analysts. In large organizations, these lists may best show the name of the activity rather than the name of the individual, together with the number of people involved in each case. At the end of report periods, which might each be ninety days, the work done and the work still to be done should be shown in order to provide the various men or the various groups of men with proper understanding. The quality of the understanding which is being secured by typical men of the various groups indoctrinated should be evaluated. On this basis, re-planning to provide the additional understanding can be done.

VALUE APPRAISAL: Wrong measurement is a worse deterrent than no measurement to the establishment of any sound activity. It often happened in earlier value work that a traditional form of measurement, which provided definitely deceptive results, had been used. More recently, the shortcomings of this type of measurement are being realized, and it is being ended. It is definitely incorrect to measure value consultants or value analysts, who use the value analysis techniques and special knowledge for the purpose of identifying unnecessary cost, by the amount of savings which result from their value alternatives. The reader will be quick to recognize that savings are the result of good value alternatives plus effective decisions and actions by entirely different people. First, the value men act to provide value alternatives; then the decision makers act to either implement the suggestions or not implement them. True, the tangible benefit to the business is the result of the actions of these two groups in series, namely, the decrease in cost and the added earnings which actually result. However, it is fallacious to use this outcome as an indication of the quality of the value alternatives or of the effectiveness of the

work of the value consultants. Changes in the value group based on such measurements may bring disaster to the business.

When the nature of the personnel in the decision group and the degree of their motivation are such that good action normally results, very poor value alternatives indeed may seem to produce large improvements in earnings. A management that gives credence to such measurements would be inclined to believe that they had indeed learned the proper type and operation for value personnel and would take action accordingly. Exactly the opposite is true; the decision group is so effective that with a very small input it produces large results.

In businesses hardest pressed for good results in value work, experience has shown that the controlling practices of the decision makers are the reverse of the above. Now, even though the effectiveness of the value group in producing value alternatives is very high indeed, very little if anything "comes out" in the increased earnings column. A management, judging by this result would be inclined to decide that its value group was inefficient or improperly staffed or organized and would tend to make changes which would destroy any possibility of improving the situation.

It should be very clear that the quality of value alternatives must be measured as such and that, as time progresses, business must, learn also to measure the quality, as such, of the decision makers ill matter" affecting value. Only then can an enlightened management make appropriate decisions and take appropriate action to restore and enhance the value of its products.

An important measurement, then, in value appraisal will be based on an evaluation of the alternatives covered by the suggestion sheets, which, as the reader will recall, constitute the output of value consultants. This must be an objective evaluation of the likelihood that the suggestion will prove practical and of the probable amount of reduction in cost which will be accomplished. Care should be taken in making these evaluations that man who has vested interests, i.e., who will later have the responsibility for either taking action to implement the alternatives or they can be excluded from the evaluation team. A suitable amount of product evaluation should be planned in discussions by the value consultants and the manager to whom they report. In this planning, the various products and product lines should be brought into view, discussed briefly, and either bypassed or scheduled for study. Measurement then follows the system of matching results with ruins. Plans will, of course, be constantly

subject to change to take into account new information learned from the results of the studies.

CONSULTATION: Important guidance on consultation is obtained from a clear review of both the consultation which has been done during the measurement period and the consultation which has not been done. In other words, these questions should be raised:

On what jobs was consultation done?

On what jobs was consultation not done?

For what men, or groups of men, was consultation done?

For what men, or groups of men, was consultation not done?

A progressive study of this type for each of a few report periods provides vital information to show where more consultation is required and also where more integration knowledge and understanding must be provided to men in other work areas.

Reports of consultation work should contain memorandum statements of activities involved in consultation, such as, "assisted engineer Smith by locating for him a double-range thermocouple of smaller size, greater accuracy, and lower cost than the product previously used.

The report will show the number of times the consultants were invited into each area and the activities resulting.

TRAINING: In regard to training, it is again most significant to have clear-cut information showing what training has been done and what training has not been done. Plans will be prepared to include all the people who should have training, either by name or, in large organizations, by groups and numbers in each group. A suitable rate will be established, and a suitable schedule for training will be prepared. This, then, will allow measuring the actual training against the plan. When desirable, the plan should be adjusted at each measurement period to account for changes in emphasis, shifts in business, or new information of diverse types.

Tests:

It is important to know whether the men being taught are learning. If the men are not learning, the trainer is not teaching. For this purpose, tests should be provided to ascertain whether those purported to be receiving training are indeed learning the fundamentals which they will require to effectively carry out their value work.

Periodically, perhaps once in a year, a study should be made of the value analysis work content in each of the main areas of the business, such as sales, engineering, manufacturing, purchasing, and management. In studying each area, it is important to examine separately the actions on the four different types of work; for example: Has suitable integration been completed? If not, what is the status and what plans should now be made?

Is the appropriate amount of product evaluation work being done for these people?. Is the appropriate amount of value consultation work being done for these people? Are the appropriate numbers of personnel being properly instructed in training classes?

Such a separate study of the four types of value work in each area of the business often brings larger than anticipated benefits. It may show that a tendency has developed for value consultants to work quite efficiently on a few of the work elements, or in some of the needed areas, and to be working very superficially otherwise. With this knowledge at hand, emphasis can be placed where it belongs to the end that a more balanced and profitable programme can be reestablished.

It is desirable, if not necessary, to have a test which can be given to the value consultant or value analyst to show, in reality, how well he is really doing in the work situations which make up the four types of value analysis work. To the writer's knowledge, no such comprehensive test exists today. Some work has been started on the preparation of such a test, and it is expected that tests will become available. It should be well recognized that in the testing and selection of men, the qualifications required are governed to an important extent by the number of people in the particular value group. For example, if one man has outstanding abilities as a teacher, plus the other essential knowledge and traits, so that he does indeed teach the subject matter, he need not have similarly high excellence in product evaluation or in value consultation. Conversely, if competence is provided to take care of teaching work, then others in that particular value analysis group may do an outstanding job in product evaluation, consultation, and integration without, in fact, having professional-grade skills in teaching, and there will be balanced competence for the overall operation.

It has been found that great care should be taken to guard against assuming that technical people who are highly competent in searching out and generating value alternatives are also capable of communicating and teaching.

NOTES

This is not necessarily true. High-grade and skilled value analysts may entirely fail at the task of teaching and training.

While a dearth of overall tests exists at the present time, the reader will find, by reexamining the chapter on qualifications for value work, that there are important opportunities for using available tests to help in the selection of men. For example, such essential qualifications as creativity, emotional stability, and technical knowledge have been sufficiently well established so that measurements and tests exist for these traits and qualifications.

9.6 SUMMARY

Check Your Progress

4. What do you understand by measurement of action and lack of action?
5. List the areas of study of value analysis.

Flourishing achievement of some types of effort requires logic and experience. Examples are the work of the plumber and the electrician. Other types of work require logic and experience supplemented by the development of certain skills. Examples are the work of the surgeon, the typist, the telegraph operator, and others. Then there are types of work whose successful accomplishment ends on experience and extreme creativity. Examples are certain types of art and some types of music production. For product work, a practical understanding of the properties of materials and their uses and of manufacturing processes, their potentialities, and their limitations is needed. For service work, the equivalent knowledge in that field is necessary. A desire to work with others and a general knowledge of how to do it are other requirements, since the work is largely an endeavor based on working with others. In regard to training, it is again most significant to have clear-cut information showing what training has been done and what training has not been done. Plans will be prepared to include all the people who should have training, either by name or, in large organizations, by groups and numbers in each group. A suitable rate will be established, and a suitable schedule for training will be prepared. This, then, will allow measuring the actual training against the plan. When desirable, the plan should be adjusted at each measurement period to account for changes in emphasis, shifts in business, or new information of diverse types.

9.7 ANSWER TO CHECK YOUR PROGRESS

1. What is the use of knowledge in training?

For product work, a practical understanding of the properties of materials and their uses and of manufacturing processes, their potentialities, and their limitations is needed. For service work, the equivalent knowledge in that field is necessary.

2. What do you understand by cooperative attitude?

A desire to work with others and a general knowledge of how to do it are other requirements, since the work is largely an endeavor based on working with others. It begins with acquiring an understanding of the job and proceeds by developing information which is often not available in ready form but which must be obtained if good value alternatives are to be produced.

3. List out the five essentials of training.

Five Essentials of Training are :

- It must allow and cause each trainee to develop his own disciplined thinking.
- It must provide understanding of reasons for excess costs.
- It must provide disciplined procedures for identification and removal of unnecessary costs.
- It must provide some new knowledge and much technique to be used in determining what knowledge to get, how to get it, and how to use it.
- It must cause and allow each man to actually use the system and to secure better results than he thought he could.

4. What do you understand by measurement of action and lack of action?

Nearly every phase of human nature promotes a negative decision on the part of the decision maker. If the value alternative can be rather promptly ruled out on plausible grounds, the decision maker is then at liberty to return to his major measured field of activity without having suffered personal loss. To provide reasonable motivation for action, measurements are needed which will clearly highlight lack of action. As soon as a fair and supportable measurement of lack of action is provided and accepted, the personal-loss factor is increased by negative rather than positive actions and significant increases in motivation result.

5. List the areas of study of value analysis.

Areas of study of value analysis are:

o How well is value analysis understood?

o How well is the value analysis organization suited to the business involved

o How correctly is the value analysis operation set up?

o How effectively are the value analysts operating?

o Do miscellaneous factors aid the value analysis operation?

CHAPTER 10

VALUE ENGINEERING AT WORK

10.1 INTRODUCTION

Value Engineering can be applied to all the functional areas. It need not be restricted to Manufacturing activities.

10.2 SALES:

10.2.1 INTEGRATION:

Make sure that each salesman, each sales engineer, and each development engineer working in sales is fully advised on what the value consultant's work is and how he will work with them.

10.2.2 VALUE APPRAISAL AND PRODUCT EVALUATION:

The first indication that a product has become comparatively overpriced often comes from experiences in the sales department. When this happens, the sales people are in a position either to turn the product over to the value consultants for value study and appraisal or to initiate action which will result in this being done by the design engineers or by other proper decision-making personnel.

10.2.3 CONSULTATION:

With reference to both new products and existing products, sales people are directly oriented toward providing the desired function to their customers at competitive prices. On the invitation of sales people, the value consultant proceeds to study the functions involved. He applies the value analysis techniques to develop values for the functions, value alternatives, and alternative courses so that the sales people may make, or promote, decisions which will meet their objectives.

10.2.4 VALUE TRAINING:

In order that sales people may bring the benefits of many of the value techniques into their daily work, a liberal number of them need value training. They will be benefited by increased abilities to identify the functions which the customers really want and to help provide the customer with what he really wants at the most reasonable cost. They will recognize these benefits and will want to be included in suitable value training programs

10.3 MANUFACTURING:

10.3.1 INTEGRATION:

Basically, all manufacturing people are engaged in some, part of the activity of endeavouring to manufacture and ship reliable high-grade products economically. This involves the choice of machines and processes, the development of methods, and the planning of patterns by which manufacturing operations will be performed and manufacturing costs will be expended on the product. Whether the product will be made or purchased is of great significance

to them. Likewise, the alternative methods of purchasing materials at various stages of completion and the economies and costs involved »re of great interest and must affect their decision making when high value is a prime objective. It is thus, apparent that the manufacturing people must be at once advised of the work which is to be done by the value consultant and of the method he will use in doing it. They will also need to learn how their particular activity integrates with the consultant's activity and what responsibilities and opportunities they have in making his value work effective. Finally, they will want to know when to call on the value consultant for information that he can prepare for them for better decision making.

10.3.2 VALUE APPRAISAL AND PRODUCT EVALUATION:

Normally, little of this type of work is done for manufacturing people, although in many cases, they are manufacturing functional opponents in certain ways and will request value studies to determine alternative means by which may provide all functions desired by the engineers and still simplify their own manufacturing

The reader must be cautioned here to note that it is not intended that value consultant should know more about manufacturing than the manufacturing people. They do not act as consultants to the manufacturing people on manufacturing methods or processes unless these are of suitably specialized nature that the value consultant is in a better position than others in the organisation to determine the sources of the required specialized knowledge.

10.3.3 CONSULTATION:

A part of the stock in trade of the value consultant is to find specialized knowledge of great depth. Therefore, he attends special exhibition special shows where he can learn of the sources of such knowledge. From these sources, he has to derive specialized manufacturing knowledge or functional product knowledge of special interest in manufacturing considerations. For that reason, manufacturing people will, on occasion, c the consultant for studies and suggestions.

10.3.4 VALUE TRAINING:

Men in manufacturing would make decisions on processes, shapes, exact arrangements, and similar factors which are needed to provide the functions expected by the engineers can derive large benefits from having a basic understanding of the use of the value analysis techniques. Accordingly all men should be included in suitable training programs.

10.4 TYPICAL VALUE ANALYSIS QUESTIONNAIRE

The Typical Value Analysis Questionnaire is as follows. The investigation is broken into headings of subject; basic question, questions are asked and an analysis is performed. This again is

formalised and a list of standard questions is used.

1. Subject : Function

   Basic Question : What functions are performed by the component?

   Analysis : i) Are all functions essential ?

ii) What other ways are there for achieving the same function

iii) Can all the functions be incorporated into one unit

2. Subject : Material specification

   Basic Question : What is the full material specification ?

   Analysis : i) Can any other specification of the same material be used?

   ii) Can any other material be used?

Material Content

What dimensions control the amount of material used.

i) Can this dimension be reduced?

ii) Is the part oversize ? by calculation, comparison, physical test, by comparing with competitors component,

iii) Can dimension be increased and a less costly material be used and vice-versa ?

Material waste

What percentage of material is wasted?

i) Can waste be reduced by making a blank smaller?

ii) Can waste be reduced by a minor design modification?

iii) Can waste be reduced by changing the method of manufacture ?

Limit

What limits are critical?

i) Can any limit be relaxed to case manufacture?

ii) Can any limit be relaxed to allow alternative method of manufacture?

Process of manufacture.

How is component manufactured?

i) Can raw material for the component be produced by a different method of manufacture?

ii) Can finished component be produced by a different method of manufacture?

iii) Can component be made to advantage in more than one piece?

iv) Can a different process of manufacture be used to reduce or eliminate labour.

Surface finish

What are surface finish requirements?

i) Are the surface finish requirements essential?

ii) Can an alternative surface finish be used?

iii) Can an alternative method of applying the surface finish be used?

10.5 CASE *STUDIES*

10.5.1 CRYSTAL OR WINDOW GLASS

In the general auditing of freight bills, it became accepted practice to expect the crystals to have a very high freight rate. However, when the time came for making a special audit of freight rates, the question arose, "How does a clock factory use so much crystal" The investigation which followed disclosed that the clock faces were indeed window glass, warmed and sagged. The investigation also brought forth the information that the transportation of crystal, a very expensive grade a glass, is extremely costly, while window glass, in any form, travels at a very much lower rate.

Crystal shipped "less than carload" costs 1.25 times the first-class freight rate, while "bent window glass," which correctly described the product being shipped, travels at only 0.85 times the first- class freight rate.

The result was that the name was changed on the drawings, in the specifications, on the orders and on the bills of lading so that, instead of being wrongly called crystal, the material was correctly called bent window glass. The freight rate was cut by 32 percent. Always "specifics" are important.

Value analysis is an intensive study; its very basis dealing, item by item, with specifics, not generalities. It requires reviewing every operation on a planning card; checking every radius, every corner, and every hole shown on a

drawing; looking critically at operations performed and establishing all that affects cost.

It follows that no effort must be shunned to get and present the essential facts. This may seem like a big job because, while some of the specifics may be easily obtainable, others may take real effort to nail down. When this is the case, the value analyst will do well to remind himself that he may let on opportunity go by unless he gets together more specifies than anyone else may easily lay his hands on.

Whenever the objective is to promote beneficial change, always use specifies. Generalities serve only to prevent changes and protect the status quo.

Meaningful costs bear the same relationship to good value as meaningful tests bear to good performance. Unfortunately, it is not uncommon to find that far reaching and important decisions are made without accurate and meaningful costs. In contrast, important decisions affecting performance are no longer made without meaningful test data.

To have available and use meaningful costs is more vital and more difficult than may be immediately apparent. It is vital because cost is influenced by every decision on every part, component, or a sub-component of a product. If meaningful cost is certain in each decision, then value may be secured. Otherwise, value is not obtainable.

There are a variety of reasons why it is difficult to obtain meaningful costs.

Cost figures normally developed are for use in a basic system intended to ensure proper income tax accounting and proper overall profit accounting for the total business and also to provide some manageable basis for liquidating necessary charges of all types. It is a popular misconception that these costs are meaningful for the purpose of decision making about engineering, manufacturing, or other value alternatives. They are not; they accomplish their indented purpose very well. However, when the purpose is important enough and the user understands the problems involved, they may serve as a meaningful cost.

The resultant cost figures, however, bear little relationship to those provided by the normal cost systems. As a homely example, same types of materials are put together and the same types of processors are used in making vehicles, the automobiles, is intended for transport on land and is very effective

for that purpose. Another type of vehicle or vessel, indented for transportation of water, accomplishes that purpose very effectively. A third type, indented for transformation by air, may accomplish its purpose very well with the same resources of material, process, and men's talents put together for its different intent.

So anyone who believes costs which have been put together in a form to accomplish one purpose can also be used for other purpose.

The cost situation is so involved that different people in the accounting business use different names to cover different combinations of the various types of cost. A few of them are:

Material cost	Decision cost
Labour cost	Shop cost
Overhead cost	Standard cost
Fixed overhead cost	Incremental cost
Burden Variance cost	Prime cost

What does each of these terms include? What does each of them mean? What types of costs are included in the terms used in the company involved?

Meaningful costs are difficult to develop because of the matter of overhead. In practice, nearly every machine and nearly every process actually consumes a different overhead. Still, for convenience of accounting, they are bunched together in some sort of grouping. How should the fixed overhead for the buildings, the depreciation, and the management of the company be appointed? How should the work of maintenance people, service people etc., be factored into individual costs? What effect on all of these expenses would different alternatives actually have?

The problem here lies in the fact that it is necessary to provide not only an answer that is satisfactory to the head of accounting or to the manager, but an answer that is also satisfactory to the economic system. An incorrect method of preparing so-called meaningful costs may be directly responsible for making wrong decisions which preclude good value in the product.

Another reason for the difficulty of getting meaningful costs is that habits, practices, and procedures are already established in most areas. People and machines are in place and things are being done in a certain way. Vested interests exist. Change often seems wrong to the people involved.

Change always brings uncertainly and a measure of insecurity to the

people concerned. Because means of allocating costs have been empirical and arbitrary, the tendency is to prolong the use of existing types of cost.

Does "labour cost" mean the amount paid to labour? Possibly, but probably not. It may include only part of the payment of labour; the remainder may be in a variance or other account caused by labour rate increase since the item was planned and the various cost set up.

Does the "material cost" show the amount which was paid to vendors for material? Perhaps so and perhaps not. Frequently, accounting practice is to add certain overheads into this account. Someone must purchase, receive, inspect, and protect material. Additions of from 3 to 20 per cent to the actual material cost for these operations are not uncommon. Thus the material cost may actually include some overhead.

Where labour and material costs include just the total of labour and material, are the figures meaningful? The assumption in this case is that the machines, the buildings, and the supervision are all in place and nothing needs to be added to the bare cost of the labour and material involved. The answer is obvious: These are indeed not meaningful costs. Obliviously, the business results will be affected negatively by taking advantage of time, people, and facilities paid for in other budgets. Decisions made on the basis will not bring value to the product.

If we add overhead to labour and material, that is, if each part or product is assessed its share of the overall overhead so that the item takes in the total of material, labour, and overhead, does the cost became meaningful? Certainly not in itself.

Many items of overhead in the business continue, and will continue, regardless of whether the particular part or assembly is made on one machine or another assembly area by a different method, or indeed is purchased from an outside supplier. Many, more overhead items are affected in varying degrees, some rather directly and others most indirectly.

The purpose here is not to penetrate deeply into accounting practice a subject on which text books are available but rather to provoke recognition that mere inclusions of overhead does not bring meaningful costs for value decisions.

What happens if we concern ourselves with labour and material plus partial overheads? It can be reasoned that overhead is divided into two groups: fixed and variable overhead. Fixed overhead takes in such items as costs of

buildings and equipment; depreciation; and general management of the company, research, and other operations that will go on regardless of the value decision pertaining to anyone product. Variable overhead covers the expanse occasioned by the particular way in which lie particular product is designed and manufactured. Such as carrying charges of special machines and machines used, foremen and supervisory personnel and other items, exclusive of labour which are caused directly by the particular manufacturing or design alternative chosen. Do we now have a meaningful cost? Perhaps the problem lies in the danger of using arbitrary or habitually percentage which may not in the slightest way show how the business is affected. For each engineering and manufacturing alternative, these overheads are probably affecting somewhat differently. Therefore it becomes necessary to understandingly study the specific alternatives involved so that the amounts if overhead expense and other additions will be in harmony in the area involved. Any margin of error between what is believed to be meaningful cost and what is in reality the true economic of the way business affected is decreased value.

What then is meaningful? To prepare meaningful costs for the purpose of making correct value decisions, the true effect of the use of the different alternatives must be interpreted in terms of dollars for several areas.

How is the business really affected?

How is the product affected?

How will sales be affected?

How will other products be affected?

How will the company's future plans be affected?

How will the development of new technology be affected?

Attainment of the desired degree of reliable performance is commonly no problem except in the case of newer products that are the result of recent research and development, and these might embrace 10 per cent of the industrial production. Where the problem does lie is in getting reliable performance at low-enough cost. Cost is the important factor in decision making in every phase of product planning, designing, and manufacturing. For nearly every function and for nearly manufacturing situation, there exist many alternatives solutions, all of which will accomplish the purpose reliably. Proper selection depends upon meaningful costs, and only when such costs serve as an essential criterion in the decision making will good value be achieved.

Without meaningful cost, decisions will not, and cannot, be made to provide value.

Example 1: There are no costs. This is a normal situation when value analysis work is done before design. It forms a satisfactory starting point. Meaningful costs must be developed, however, for each of the alternatives that might be used.

Example 2: Costs exist but are not provided. Seldom, if ever, is value work efficiently done if costs which exist are not brought forth. Getting good value is difficult. All possible help is needed.

Knowing present cost set certain floors and ceilings with relation to different types of alternatives. This saves time and helps show where the work will probably be most effective.

In contrast to performance-oriented work, it is often desirable in order to secure good creativity, to avoid knowing how others have accomplished the desired function until some study has been made, otherwise the thinking is often channeled into the types of solution that are known to have been used previously, with the consequence that excellent value alternatives which might accomplish the total function reliably for a small fraction of the cost are not brought into view.

To summarize, start out with the best costs that exist, understand them, know their deficiencies, and gain all possible benefits from them.

Example 3: Data exist but only labor and material costs are provided. This situation is some- . times found in areas in which competition has not forced a high degree of value. Normally labour costs are known as non- material costs. Furthermore, it is known precisely how much of each applies to the product in question. The easy, habitual way is to accept these as the costs. No interpretation, no imagination, no direction, no forethought, and very little effort are required. In contrast, if some or all the pertinent overhead figures are included, the questions arise: which one? How much? What percentages? etc., these require thought, study and understanding. Where only labor and material costs are provided, the action taken is usually justified by various forms rationalization: for example, "Direct costs of labor and material are about all that are affected by change any way; overheads continue relatively the same."

Again efficiency of value work is reduced to the extent that pertinent costs are not brought into the picture.

Example 4 : Decision cost-so called "out of pocket cost" in make-or-buy decisions. A general statement, specific enough to have some validity, is that meaningful costs for use in make-or-buy decisions will include:

Labour

Variable overhead some amount of fixed overhead

Normally, all labour, material, and variable overheads are included. But, considering all of the effects on the business, on costs, on sales, on other products, etc. the question is: What percentage of fixed cost should be added to arrive nearly at an out-of-pocket cost which will show how the business will be affected?

Although there are many important factors, the most significant consideration normally used is the amount of work in the plant compared with its capacity. When machine or facilities are only partially loaded, it will be observed that some machine are idle, floor space is not filled, some people work for short time, and other people are obviously, "stretching " less important work in order to make a full day of it. Legally felt that the costs for make-or-buy decision or lower in this situation than when the plant is working at full capacity or over.

It will be seen that the amount of fixed overhead liquidated in the cost of the particular product is reduced as the plant work load increase, the amount fixed overhead applied in the comparison figures is increased, tending to minimize "keep-busy work" and to open up capacity for essential, productive, profitable products which must be manufactured in the area.

Example 5: Decision cost involving make one way versus make another way in the factory.

The general practice is to use labour plus material plus variable overhead plus or minus significant changes in the way fixed overhead is affected.

In conclusion, the costs used often make the decision. Therefore, any wrong action taken in preparing cost means a wrong decision any resultant poor value in the product.

10.5.2 UNMEANINGFUL COSTS USED FOR DECESION MAKING CAN BANKRUPT THE BUSINESS

Word was received that severe customer resistance had developed to hamper the selling of an important electromechanical control. Advices were that all the assemblies, subassemblies, and parts were laid out for study and that each was labeled with costs, quantities, etc.

Even first examination showed that costs were extremely high. For example Twenty-cent items often cost 50 to 70 cents.

Two-dollar items often cost \$4 or \$5

Three-cent items cost 50 cents.

Eight-dollar sub-assemblies cost \$21

Study was undertaken to determine why costs were so high. Some of the reasons follow:

1. Parts were being made on less than optimum equipment.
2. Parts where often made by skilled labour when they required none.
3. Inventories of some parts were extremely high.
4. A "blanket" fixed overhead rate was used on all items whether the fixed asset used consisted of a screwdriver or a \$20,000 machine.

INTERPRETATION: Cost figures which were used for decision making and which had been responsible for overpricing the product were not meaningful because:

1. The use of blanket fixed overhead regardless of the fixed assets used prevented decisions makers from knowing how the business was really affected by the various alternative methods for accomplishing the necessary functions.
2. The job was used as a "filler" to take up the slack in the factory. Whenever machine time opened up or men had no other jobs, parts were made for inventory. Labour costs were not meaningful for decision making between alternatives because they were often based on uneconomical short runs on the use of much higher skill than the particular items required. Set up costs were not meaningful for decision making because they were based, not on other considerations.
3. The volume of the work in the factory was being reduced because unfortunately, the selling price of the product was being influenced by the summation of these costs.

Even a glimpse at the cost realities shows that included in these "carefully delineated" costs of parts, sub-assemblies, and assembles were these costs.

1. The legitimate cost of producing the functional parts, sub-assemblies as they were designed Completely extraneous cost for factory load balancing.

2. Costs for totally unused items of fixed assets. It was decided that two activities would at once proceed.

   1. Determination of appropriate costs, applicable to the particular parts and assemblies being manufactured.

   2. Using the value analysis techniques, evolution of all functions of the product was arrived at.

With the meaningful figures of cost for accomplishing the various functions by means of present designs and with a clear view of the value of these functions, alternatives were developed where poor value existed.

The result was practical alternatives as a basis for decision making which would reduce the total cost to less than half.

Use information from only the best source

Lack of full information and use of misinformation are frequently the cause of poor degree of value. In recognition of this, the search for pertinent information in value analysis must be a continuing one, and likewise, the sources from which the information comes must constantly be weighted to ensure that they constitute the best ones available. The more and effective the search for the best information, the better the value attained.

Questions by the score must be raised, and answers must be accepted only from the highest level of the best sources in each case. Some examples of the sort of questions that should be asked are:

Why is this square?

Why is it painted red?

Why does it have a double set of contacts?

Why is it "hogged" from solid bronze?

Why is there a 0.0001-inch tolerance on the diameter?

How does the customer mount the base?

At what atmospheric conditions must it work?

In what positions can it be mounted by the customer? What limits its market?

What causes it to be noisy?

What benefits does the F4 finish on the inside of the cover bring?

Answers traditional to the thinking within any area are readily available. Experience shows that such pat, traditional answers must not be accepted.

Whatever the pertinent question is, only the best source must be allowed to answer it. The following examples are offered in verification of this;

Who is the best source, the engineer or the sales manager? In the value analysis of a moderate-sized piece of electrical equipment, a partial inside cover was found which had a cost of $5. The analyst, in analyzing functions, could find no function for it. Accordingly, in reporting to the engineer in charge, he said, "This cover costs $5 and I can find no function for it." The analyst at once recognized this as quite a normal situation, in which the engineer voiced his belief; in fact, he voiced the criterion on which the decision to retain this cover had been made for years. The analyst's suggestion, therefore was, "why don't we ask the sales manager why it is that the customers require this cover if it seems to us to have no functions." When the question was subsequently put to the sales manager, his answer was: "Does that cost $5? Take it off. I have only one customer who used it. The others take it off and throw it away. I will see to it that this particular customer pays a special charge for extra equipment."

Again who is the best source, the sales manager or the purchasing agent? At a manager's staff meeting, it was being determined whether or it not was practical to increase production of same appliances from 2,000 to 4,000 per week. The marketing manager said, "In this market we can now sell all we can make. However with shortage of steel, we can't get enough to support a schedule of any more than 2,000 a week, "this statement contained what is believed, for the very good reason that he had made enquires. He had talked from time to time with purchasing and had read in the trade magazines about shortages of steel. Just before the group made its decision, the engineering manager said, "Should n't we call in our purchase agent and get a direct up-to-the-minute reading from him on this shortage of steel?" That was done and the purchasing agent, like most competent men, knew more about "his business" than anyone else. When told that they wanted to increase the schedule to 4000, he told them to increase it; he would furnish the steel. Thus a loss of potential business was narrowly averted by merely going to and accepting the answer from the best source. What the purchasing agent did was to buy some of the necessary steel components in a partly finalized from, and by so doing, he properly utilized the steel allotments of various component manufactures for whom he provided good business at the same time that he met his own quota of 4,000.

Who won't approve it, the Underwriters? A value alternative suggested for a small transformer would reduce its cost 20 per cent and seemingly provide all the functions, as well sufficiency and reliability. The answer from the engineer was "The underwriters" won't approve the change." For the answer to the resultant question, "why won't under writers approve ?"communication was made directly with the under writers". The answer from the appropriate personnel in the under writers ' office was: "Proceed with the change. Several years ago, under different conditions of application, we felt that the transformer should be made in a certain way. However, we have since changed this requirements as the added expanse makes no contribution to safety or performances."

10.5.3 THERE IS ONLY ONE SUPPLIER

A Special instrument required a glass cover, about 10 inches in diameter having a curved shape similar to a bowl and having an inch hole through it. Its cost was \$ 1.25, and the quantity used was about 20,000 per year. The value analyst was told, "There is only one supplier for this type of part, and though we recognize that the costs seems high, we have little choice."

Realizing that the buyer in a specially department was not the best source for knowledge relating to clock and instrument faces, the analyst asked the buyer at a clock factory if he could suggest suppliers for the part. The answer comes back, "we have six excellent suppliers for this type of part." Drawings and specifications were sent to some of these suppliers, and the result was that, for exactly the same item, the cost became 50 cents rather than \$1.25.

It always pays to locate and consult the best source.

Blast, Create, Refine

This is a special technique usually helpful in reaching value objectives. Its purpose is many. First, it serves to eliminate what is in immediate view so that the mind is no longer channeled and so that thinking in totally different; more effective directions is not stifled. Second is direct thinking to basis considerations. Third, it provides a mechanism for building that which is needed on these basic considerations.

The use of the technique is often very painful to the originator of a design or a plan. His solutions are his brainchildren, so to speak. In arriving at them, a great deal of effort was expended. Studies were made, money was spent, and the aid of others was solicited, and so on. With the concept evolved

and the plan put together, the designed and manufactured product has truly become a part of the individual. To him, the idea of "blasting" is inwardly revolting. It is as though a part of his being were about to be destroyed.

These mental reactions are emphasized here because the whole technique of blasting, creating, and then refining is a mental, not a physical process. It can be extremely productive when people are mentally trained to understand and use it.

In the technique the functions are first brought into very clear focus. Then the possible means of providing the function are reduced to over simple terms. The necessary complexity is then added. Alternative means for adding the complexity come next. Where good grade value is required, this procedure is necessary to common controlling the causes of why things are done as they are. The common controlling factors are the habits and knowledge of the people at the time the particular thing, whatever was first done and when it later was modified as different processes and other people came into the picture. .

For example, the three-room house so typical in the middle west in earlier days provided accommodations for living, cooking, and sleeping. Sanitary facilities were outside in a nearby building. This house was functional and appropriate to the circumstances of the time as they were then known and interpreted by the people involved. Later, a lean was added to include two sleeping rooms as both girl and boy children came along. There followed a lean to for the hired man. When the family became overcrowded, another lean ; the kitchen was added and the *former* kitchen was converted into eating space. With the advent of modern plumbing , a further lean was provided for a bathroom and the outside facilities were likely to be remodeled into tool shed. Intense study of any product shows that it is to a greater or lesser degree. Even the new product that value work will bring forth will be to some extent, of a similar nature.

This situation raises the following vital question in the search for better value.

How can this chain of influence be periodically stopped?

How can a function needed today, in the light of today's knowledge be looked at objectively?

The technique of blasting, creating, and then refining is specifically directed towards accomplishing these objectives. The aims of the three steps in the use of the technique are;

1. Blast. In this stage (keeping in mind the basic function to be accomplished, but not expecting necessarily to entirely accomplish them) alternative product, materials, processes or ideas are generated. These alternatives should, first of all, qualify for accomplishing some important part of the function in a very economical manner or at least, serve as an important part of the function. At the same time, the precise amount of the function which would be accomplished and the specific cost which would result are brought into clear focus.
2. Create. Using intense creativity, this step should serve to generate alternative means by which the concepts revealed by the blasting can be modified to accomplish a large part of the function with pertinent increases in cost. In this creative part of the technique, definite integers of increased function are associated with definite integers of increased cost.
3. Refine. In this final step, the necessary alternatives are added to the function which would be accomplished by the blasted product. These are further tested and refined, adding additional integers of function. With additional integers of cost. Until the refined product fully accomplishes the total function. It is not uncommon for the result that newly constructed product concept to accomplish the total function with the same reliability and overall benefits for a cost of one half to one tenth of the original.

The following are excels of execution of the three steps. The selection of the three most common simple fasteners- the nail, the screw, and the bolt- is made purposely for the sake cleanness

To blast a steel nail. Let us compare its cost with that of steel wire of the nail diameter, which surely is capable of performing an important part of the function of nail.

In our blasting of the nail it is recognized that additional work must be done on the steel wire to make it accomplish the total function of the nail. Our next step must be to create, for review, a list of alternatives which will serve for the function of the head, such as

1. bend the wire at one end
2. flatten it at one end
3. weld a small piece at one end

In refining, we first look again critically at the total function of the nail. Second, we review the basic cost of the material from which the nail is made, as found in the blasting, and also the amount of function which the wire alternative fails to accomplish. Third, we develop the ideas arrived at in the creative approach to a point where the ones most practical can be selected for further consideration, and we then select one or two of the approaches which will provide, at a minimum cost, most of the required additional functions. Fourth, we critically review the new approach, which embodies the blasted concept plus the created additions, and determine whether the function is totally accomplished with complete reliability. Also, we ask: have the lowest-cost practical solution been selected? If the function is not totally accomplished with complete reliability by selected combination, we must refine further by adding additional increments of function and cost so that the new product becomes totally usable.

Screw

To blast a steel screw, it seems reasonable to compare it first with steel wire of proper diameter and then with the nail in each case, we identify appropriate costs.

Starting with the alternative of a nail, we proceed to

1. cutting the thread
2. rolling the thread
3. coining the thread
4. accomplishing the function of the screw without a thread,
5. coining a slot at the head end
6. milling a slot

Again we combine the best alternatives produced by the blasting and the creating, adding in each case the integers of function for which the screw is to be used and make necessary refinements by adding additional function and additional cost until the product will accomplish the total function completely and reliably.

To blast the steel bolt, we may similarly compare it with steel wire rod of the appropriate diameter and in the appropriate amount, then with a steel spike or nail, and finally with a steel screw. In addition we study the function which is intended for the bolt and, if possible, draw comparison with other basic ways of accomplishing the same fastening function at a much lower cost.

From among the blast alternatives, we may start here with the wire or rod necessary and produced to

1. create alternatives at the end as was done in the case of the screw
2. create alternatives at the head end
3. extend the function to determine what variation of alternatives can be provided for the particular application. In each case, we should attempt to bring into view, at least for preliminary consideration, a considerable number of alternatives.

For the refining, we follow the procedures described above in connection with the screw. The more complicated the product, the better are the opportunities for wide use of creativity and for the searching investigation of value alternatives which will accomplish total function reliably for very much lower cost.

The blast approach may often be used also on individual elements of the cost. For example, let us take the case of a counterweight that cost 6 cents. Its function was not providing weight. It was used in a completely enclosed assembly with no parts other than its support near it. Simple analysis showed that its use value was 100 per cent and its esteem value 0 per cent. The amount of $2,000 per year was paid to grind a small flash from the casting. This flash did not affect the weight or the counting or the environment.

The function "secured for the expenditure of $2,000 was blasted and revealed that the grinding provided no use of function. With no esteem function, any expenditure which does not provide a use function represents total waste. Accordingly, the grinding operation was blasted to zero and eliminated from the cost.

Looking back, it's seen that it was quite normal to accept the $2,000 cost because it is normal to grind the flash from the castings. It is the way such things are done. It represents the way people who are used to handling casting operate. It is accepted by them, on the basis of their years of experience, as a normal, proper, and necessary operation to add to casting making.

The reader will learn to recognize that the accomplishment of outstanding results will defend, in some instances, upon expertness in the use the "blast" portion of this technique; in others, ex-pertness in use of the "create" portion will be largely responsible for extremely high-grade results; in still others, extreme expertness in the "refine" portion will bring forth the optimum results.

It is important that the value of effectively using each portion, when and as it is needed, be understood and, further, that the emphasis in each case be placed where it is needed. The examples that follow will aid in recognizing the validity of this statement.

Example 1: **A needed part was a piece of quarter inch copper tubing two inches long. It's cost was 4 cents. Here are the results of applying the three steps of the technique.**

Blast: The basic cost of the required amount of copper tubing at the mill was found to be *1*cent.

Create: The first alternatives were to draw the tubing straight at the mill, box it in 20 foot lengths, and ship it to the factory for cut off. The second alternative was to draw the tubing but wind it in coils and ship to the factory for straightening and cut off. The third alternative was to arrange to have the tubing cut off at the mill as it was drawn and so eliminate the need for boxing straightened lengths for a costly shipment or for coiling the tubing and having it straightened at the factory.

Refine: Putting together the costs, the figures for alternative 3 were:

Material	$ 0.0075
Cutoff	0.0010
Boxing and freight	0.0017
	$ 0.0102

Quite obviously, the third alternative appeared to be the proper one subject to refinement. What refinement was necessary? In the particular application, it was essential that there be no burrs.

Therefore, the cutoff equipment had to be inspected and samples of its work had to be examined for burrs. This examination proved that the high-speed cut off equipment accomplished its work effectively without leaving burrs. The final result was that the cost for the part changed from 4 cents to 1.2 cents.

Example 2: **The clamp bar is made of steel with two l-inch threaded holes. It is 2 inches long. Required quantity is 4,000 per year.**

What is the function? Half concealed inside heavy equipment, this clamp bar performs a basic function which could be provided by two 1/2-inch nuts. It does, however, also provide the secondary convenience function of compensating for the fact that there is no space in which to insert a wrench to

hold individual nuts during the tightening operation. Further, the clamp bar is desirable to keep individual nuts from becoming loosened during the use of equipment. The equivalent to that which would be performed by two nuts, plus some type of secondary fastening function. Such as could be provided by welding the two nuts together, welding them to a common piece of metal, or pressing them into some sort of holder which would keep them together.

Blast: The basic function for which this part was designed, we find could be accomplished by two nuts which cost less. Hence, the value of the basis function is 3 cents. This represents a typical blast finding. We have an alternative which will provide an important segment of the function, though it will not accomplish the overall function. To do that the nuts must somehow be fastened together.

Create: How to fasten together is the subject of the second step, and we arrive at these solutions:

1. Weld the two nuts side by side.
2. Weld the two nuts to a piece of wire.
3. Weld the two nuts to a piece of sheet metal
4. Press the two nuts into two holes in a piece of sheet metal Approximate costs for the above to be worked out.

Refine: Particular complications or problems to be solved in each case are now generally considered. While so investigating, we find that a vendor makes and sells weld nuts of the proper size. Further, we find that the factory has proper facilities for making a small stamping and for a welding the two nuts into the stamping. The result of the blasting, creating, and refining is the double nut in assembly ;its cost is 8 cents, while the cost of the clamp bar had been 32 cents. In other words, by applying the technique, an alternative is provided which reliably accomplishes the overall function for one-fourth of the cost.

Example 3: Here we are concerned with a small radio-frequency transformer about twice the size of grain of wheat and costing 39 cents. It is used in large quantities. What is the function? The normal function of a transformer is to effect a useful transfer of electrical energy between two coils. For that purpose, one coil of wire is brought in close physical proximity with another coil of wire. In this type of product, it is most profitable to divert the thinking from the end function to the structural function. Basically, the problem becomes one of reliably holding two coils of wire in an appropriate physical

relationship. In this case, "holding" was found to be accomplished by winding both coils of wire on a very small spool. Four, almost microscopic, holes were then drilled in the ends of the spool, and the four necessary ends of the two coils were threaded through and pulled out of these holes. Study showed that the two coils of wire accounted for less than 10 cents of the cost. The cost of the spool, the drilling at the ends and the threading of the wires through the holes in the end made up the bigger part of the cost.

Blast: use only the two coils of wire. Put the two coils on a tooth pick-size piece of wood or plastic.

Create:

1. Discontinue drilling the spool ends and the subsequent threading of the fine wires through the holes.
2. Use a drop of adhesive to hold the wires in place.
3. If the spool ends are not to hold the wire, they will not be needed, and so we can discontinue using the spool.
4. Use a straight piece of suitable plastic or insulator material, wind on the coils, and secure the wires by a drop appropriate adhesive.

Refine: By using only the coils as indicated from the "blast" step and the small insulator and adhesive (alternative 4) to maintain them in rigid relationship to each other, the electronic function can be accomplished to considerably less than half the original cost. However, we are now short a means of supporting the assembly in the equipment. To provide for this, an additional small mourning part can also be secured by the drop adhesive. The new cost is 19 cents. The annual cost, which had been $78,000 is now $38,000.

Example 4 : Radar-control mounting

In military equipment of the radar type, it is often necessary to have a control for centering spot on the television like screen. This "joy-stick" assembly consisted of a mounting| plate about 6 inches square with a small level about 4 inches long extending through the centre. The lever could be moved in any direction, and as it was moved, it electronically caused the spot on the screen to move in the same direction. In back of this plate were suitable gears and mounting for the lever and four potentiometers: two operating at right angle to the other two. The total assembly cost $127. The potentiometers which accomplished the electronic function accounted for $3.60 of this cost. For the required simple, imprecise manual movement of $4 worth of electronic gear, $123 worth of mechanical gear was used.

The overall function was that of electronically providing decreases in certain currents and increases in others so that the spot could be guided to the centre of the screen. For the purpose of providing better value alternatives, this total overall function is best divided into a number of sub functions which became quite manageable value wise. Basically, the mechanical functions of the device consist in mounting four small potentiometers with an operating handle so that the handle can be moved through the proper range to adjust to the potentiometers for the proper operation.

Blast: For this item, with which the hand moves a small lever until the eye sees that the spot is in the centre, it would be seem that a very simple mechanism for the mounting the lever and the potentiometers would accomplish the total purpose and would be low in cost.

Create

1. A standard or a modified ball-and-socket mounting with suitable linkages to operate the potentiometers.
2. A simple "double axis" mounting with the axes at right angles.
3. Standard control levers with their mountings, as already provided and available for other applications

Refine. A study showed that the principal reason for the high cost was that the potentiometers had to be moved through 300 degrees to get their complete variation, and to that end, it was necessary have a considerable number of gears back of the panel in order to magnify the 90-degree motion of the lever though panel. It was further found that a plus or minus 20 per cent variation tolerance was properly specified for the potentiometers, because in this application, any specific benefits from close tolerance would be cancelled out by differences in the motion of the hand.

The vendor was asked for quotations based on providing potentiometers which would vary though the same range with a motion of 90 degrees. This he was able to do, but the potentiometers became "specials" and a cost increase of 10 cents was added to each. Therefore, instead of $3.60 for the four standards, $4 would have to be paid for the four specials. A basic model was promptly provided for $11 to meet other physical conditions of the equipment. This was further refined to an interchangeable component which met all of the operating specifications and had the same reliability at a cost of $30. Three-fourths of the cost was removed and all of the performance reliability continued. This is a typical result of applying the technique.

To summarize the very useful value analysis technique of blasting, creating, and then refining serves first to bring the needed functions sharply into focus. Then the meant being used or planned to accomplish these functions are critically reviewed and blazed by comparing them with process, products, or materials which would accomplish only part of the function but which would have a small fraction of the cost. This is followed by an extensive and intensive creative effort in which a series of significant alternative for accomplishing the total function or each part of the function or the causing other methods to perform satisfactorily are brought into view. In a subsequent refining effort, the total needs for the application are objectively considered in the light of all the information developed in the function study and in the blast and create phase and a suitable combination of alternatives is established for reliably accomplishing the total function at a cost lower that that existing.

10.5.4 THE ELECTRIC CONTROLLER

Electromechanically controllers, approximately 1 x 1 1/2 feet in size, were required in quantities of 1,000 per year. The product performed its function well and had received good acceptance in the market several years. With the constant march of progress, it was apparent that the selling price would have to be lowered, which in turn meant that costs would have to be lowered. A team of man from the engineering and manufacturing, purchasing, and cost department was assigned to go over the controller in detail. Their work culminated in the reduction of costs by above 10 per cent. While this reduction was adequate to meet the market conditions at the time, it certainly allowed no leeway for the unexpected. Hence the manager, who had heard the value analysis approach, arranged to have a man make a value audit of the product using value analysis techniques. Starting again with the function performed by the assemblies, the subassemblies, and the parts and evaluating these functions, value alternatives were developed which would reliably accomplish these functions.

Some of the items, together with the particular changes affecting them, were as follows:

Small hinges were made by buying an extruded section, drilling the hole for the pin, and then drilling mounting holes in the flat portion. The cost was 28 cents. By using a 1/8 X 1-inch steel strip, cutting it to length, rolling it at one end for the hinge pin, and drilling it for mounting, the cost became 10 cents.

A steel hub *2* inches in diameter and 1 inch thick, with a 1/8-inch hole drilled in the centre and six small holes drilled amount and near the outer circumference to serve for mounting two small 6-inch diameter by 1/16-inch thick aluminum dials, cost $1.27. The search for a specialty product which would perform this function revealed that aluminum companies sell slugs, i.e., round pieces of aluminium punched from sheet stock, for use in impact extrusion machines making toothpaste tubes and a wide variety of similar containers. It was found that one of these slugs, 2/i inches by '/« inch in size, could be secured for 4 cents. However, it was slightly cupped, and the judgment was that for the application in question it needed to be flat. This could be accomplished by a flattening operation costing I cent. The operation of drilling the centre hole and the smaller holes for mounting the dials came to 8 cents, giving a total of 13 cents instead of $ 1.27.

Plastic cams, 1/4 inch thick by 2 inches in diameter, having the equivalent of saw teeth, approximately eight per inch, cost $ I each. By reviewing the product with the plastic supplier, it was determined that orders placed approximately twice each year rather than more frequently in very much smaller lot sizes, as had sometimes been done, resulted in a price of 20 cents.

A 5/8 inch ID by 7/8- inch OD by 3 -inch-long colour drilled and tapped for radial set screw cost 36 cents. It was made on a screw machine. By changing the raw material to a heavy-wall tubing which was cut, burred, and provided with a drilled and tapped radial hole that came to 10 cents.

A special jam nut costs 20 cents. A standard jam nut of the same general description cost 1 cent. However, the distance across corners of the standard nut was slightly too large-1/32 inch to avoid interference with the smallest-size gear which, under some conditions, was used in the mechanism. A slight modification was made in the mounting arrangement, and the cost became 1 cent.

A small spur pinion, approximately 5/8 inch in diameter by 5/8 inch long was being machined. Its cost was 65 cents. A supplier was found who could provide the pinion stock of the proper size and thread so that the factory merely needed to cut it off and burr it in order to produce an interchangeable pinion for 40 cents.

Three switches and a switch mounting place were purchased from the same supplier for 85 cents. They were routed to the factory and put together into an assembly. The cost of the assembly was $1.33. The particular supplier

was asked to provide the assembly ready for use, shipping only one part instead of four. This eliminated much inspection, mounting handling, storing etc. the supplier offered delivery of the assemblies ready to use at $1.

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A bracket in the form of a U was made of 1/8 x 1-inch steel was about 6 inches long, with each end turned up approximately 7 /8 inch drilled. The cost of the bracket was 48 cents. In studying the re-it was found that one operation- a special straightening and between the two bent-up ends within extremely close tolerance. This sizing operation was said to be required so that the as: under all circumstances. A bearing block was made by buying extruded material, cutting it into lengths approximately 12 inch long, and drilling a large mounting hole for the bearing and two Tran serve holes for mounting the block. It cost 65 cents. It was further found that the bearing in a section that was bent up at right angles, would accomplish the function with the same reliability for 20 cents. It was further found that the bearing which was being used cost 11 cents, whereas a suitable flanged bearing would fit ideally into the assembly and cost 3/2 cents.

The device contained a dust cover which was open at the bottom and hinged on the side and cost $5. As reported elsewhere in the text, the cover appeared to have no function, but the engineers believed that it was necessary to provide it on the product in order to please the customers. It was found that only one customer wanted it, so the item was eliminated except for that one customer wanted it, so the item was eliminated except for that one customer, who then paid for it as special equipment.

A large assembly called a motor plate pointer assembly was made of 1/8-inch steel approximately 5 inches on each triangular side, with a welded pointer rising several inches and with teeth cut on edge. Its cost was $ 1.80. in the value study, its function was evaluated at considerably less. A review of the cost build-up showed that these steel parts were being copper plated, chemically blanked, and then lacquered. Newer process for chemically blackening steel directly, to provide good surface protection and a good appearances finish, were investigated and resulted in a decrease in cost to 80 cents.

A panel costing $2.28 was also carefully investigated. Each point of specification which caused increased cost was studied, and such actions were taken as were desirable and possible. Among others, care was taken the control the ordering quantities to eliminate unnecessary steps. The cost decreased from $2.28 to $1

All these and other changes, none of which in the least affected the needed function, were responsible for a 40 per cent reduction over and above the 10 per cent removed prior to the application of the value analysis techniques. Tooling costs in this case were almost negligible-less than one-fourth of the annual saving.

Use Real Creativity

When a new and better method is needed to excel in competition, it may be sought by either of two means. The first and most common is to observe, in other products and process, the approach that accomplishes functions that are similar to the function required and then adapt that approach. The other means is to produce mentally a new approach-one that has never been seen and, perhaps, one that has never before existed.

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The process is called creativity. In using it, knowledge integers, or in modern-day computer language, bits, that have not been associated before are connected; or associated. For example, growing green grass has not been commonly associated with the hood or exterior of an automobile. Some paint-like material is usually associated this way. To consider growing grass, which must be periodically cut, as the finish for an automobile is new association. Thinking that could later spring from

the association has a better chance of being totally new. Unfound good solutions are more likely to be found and the finder can reap the original benefit during the period when these solutions are being copied by competitors who are not using creative problem solving.

When value analysis is used for the purpose of assuring profitable success in competitive markets, it is absolutely mandatory that good creative thinking process be used. As soon as functions are clearly known, the problems can be "set" in sentence beginning with "How might we..." and intense creative thinking can and must begin.

The most common obstacle to deriving results from attempts to be creative in developing ideas lies in the natural tendency to let judicial thinking interfere with mental associations. For that reason, the main requirement in applying the creative technique is to defer judgment. Unless that be done, "It won't work" or "specifications won't allow it". Such negative thoughts hamper a free flow of imaginations; the things that they imply must be left to be explored in a subsequent step.

Another obstacle to getting creativity into action is the tendency to associate creative thinking with intricate and complex problems. The fact is that even the simplest problems benefit from being dealt with creatively. The thinking to guard against here is the application of the creativity by laying out a special pipe plug that served the function well indeed, at a manufactured cost of $15. Had he applied his creativity to searching out the best plug for the purpose from available supplies, he would, no doubt, have chosen to purchase a perceptively serviceable plug from a local plumber dealer at $3 thus avoiding a needless outlay of $12 that returned no value.

A third cause of restricted use of creative thinking is often found in the difficulty people may experience in getting a chain reaction of ideas ignited and then sub stained. In such instances, experience indicates that brainstorm session with, say, three or more participants' works wonders. In the competitive atmosphere of such sessions, one individual's idea soon stimulates other ideas both in the mind of the individual himself and in the minds of his associates. The extent to which this happens is indicated by the following yields of two group-brainstorm sessions. In the one case, the problem was "how to detect that someone is at the front door and wishes admission" the record of that sessions showed a total of 109 different ideas for solution of the problem. The other instances had to do with how to join together two electrical conductors. Here, the record was comprised of 140 varied ideas.

Sight solid not be lost, though, of the fact that an individual; by himself can stimulate his own imagination or creative thinking by very simple expedients. For instances, anyone confronted with the problem of how to best join two float pieces of material may derive helpful suggestion from merely glancing observantly around the ordinary office. As the eyes pause on the paste bottle, the cement tube, the scotch tape roll, the paper stapler the hole or the clip tray, the mind is automatically directed toward the alternatives of pasting, cementing, taping, sticking, riveting, and clamping the piece together-.

Whether the application of creativity is excised by the individual alone or in group brainstorming the important factor, as already indicated, is to let no judicial thinking eliminate any idea that comes to mind, regardless of how radices it may sound at first. Every idea that emerges sportingly deserves to be jotted down for further consideration. What this means than is that whenever the ready flow of ideas stops, each idea on the record must be evaluated in terms of what selected its development may have on the ultimate goal. A farfetched idea may be appear to hold the best promise of yielding the most substantial benefit in its developed state. Thus idea, rather than the idea that seems the easiest to develop, may be the one to concrete on. In this connection, it is well to bear in mind that development work on one idea frequently leads to other ideas of even greater benefit. Hence no idea should be forsaken until an attempt has been made to develop it to the extent that it deserves.

EXAMPLE 1: The United States Navy's bulkhead-penetration project culminated in the use of a combination of fiber supports and epoxy-resin sealing by air-gun extrusion. Compared with the standard variety of metal bulkhead penetrations, the cost of the new method came to one-fifth of the earlier cost and opened up opportunities to make sizeable savings more than $70,000 a year in one naval shipyard

EXAMPLE 2: Application of squirted-in self-vulcanizing material to take the place of ready-made rubber gaskets resulted in a cost reduction from 11 cents to 1 cent per seal. This solution went back to someone's inquisitively asking himself, "wonder what use I could make of the jar-sealing gaskets that my wife buys for practically nothing at the dime store?"

Because the methodology of creative idea development is a subject that in its own right is illuminated by several good books and many courses in universities and elsewhere, it would be redundant here to include the step-by-step procedures for obtaining good results. Suffice to say that creative idea

development must be mastered and used by anyone who expects to use value analysis effectively.

Identify and overcome Roadblocks

There is hardly a person living who has not been impressed by the effectiveness with which some product accomplished its purpose, only to be superseded sometime later by modifications which performed the same function much more reliability at much lower cost. It is normal to accept, as being "near perfection" the good work which has been done on sometime that accomplishes its purpose well today. It is shocking to later learn that the same functions could have been performed s much better at a lower cost even at the earlier date.

Why, then, were these functions not accomplishment at lower cost earlier? Something prevented it. Most likely, continuation of the study involved ceased, as did work that might have resulted in improvement. Design and manufacture were entered on the product as it was. In some instances the material or process that would yield the function at a lower cost was nonexistent at the time of the earlier design. Experience shows, however, that, in nine out of ten cases, applicable processes or materials or perhaps special products did exist and could, in fact, have been included in the earlier design and manufacture.

The natural question here is: "Would not benefits have resulted from putting into earlier use such processes or materials which accomplish the total function more reliably, perhaps more simply, and at lower cost?" Checks indicate that the answer is usually "yes," What, then, stopped action for better value in nine out of the ten cases? Roadblocks-occasionally real but mostly imaginary, occasionally technical but mostly human.

The purpose of the technique of identifying and overcoming roadblocks is to help develop these situations and prevent value work from so often stopping short of adopting accomplishable value alternatives. A roadblock, as that term is used in the present connection, is a decision that prevents timely development of appropriate value alternatives. The cause of it may be a lack of information, acceptance of wrong information, or a wrong belief. These factors cause the decision mater to decide that it is not wise for him to continue to work toward lower costs at the particular time. The sort of roadblock in question occurs after tests have shown that the performance objectives have been met. Value objectives, being lees clear and not as measurable, are given secondary consideration and decisions tend to be made to proceed with the

drawing up of the designs, with the building of tools, and with manufacturing, Some of the common roadblock met with are:

There is no better material.

This is the best proceeds considering quantities.

There is probably no better way of doing it and we are short of time anyway.

This has been proved to work. We won't change it.

Underwriters' wouldn't approve any other arrangement.

This is the result of a lot of study. It will be far better than competition.

We changed that a few years ago and got into an epidemic of trouble. We are not changing it again.

We had to maintain interchangeability. It can't beat an automatic screw machine for any part that it can make.

We have ten turret lathes; we certainly make money by designing to keep them busy.

There is no other source of supply.

We know more about this than anyone else

There is no plastic with those properties

It is impractical to make castings that small.

It costs too much to change the drawings.

The customers like it this way.

It is important to bring these roadblocks clearly into the open and to recognize that the usually represent the honest beliefs of the men who make the decisions. To achieve improved reliability, simplicity, and lower cost in these circumstances, more correct information must be injected into the situation with proper timing and presentation so that the decision maker will use it.

EXAMPLE 1: Rather large quantities of asbestos paper were used for one application at a time when asbestos was in short supply and was, besides, a costly item. Its function was to catch paint drippings in a dip-painting line. When the value consultant questioned the use of asbestos for this, he was told that it was the only material that fit the specification and had the approval of the fire-safety committee. The roadblock clearly was that the fire-safety committee would not allow the use of anything other than asbestos paper. New information was searched out from manufacturers of special papers, and

when it was found that "nonbonding" paper could be made, samples were obtained. Tests were made and the new paper proved to serve the purpose reliably. Based on this new information, the roadblock was overcome. The result was an improvement of value and a lessening of procurement problems.

EXAMPLE 2: A stainless-steel nipple for conduction water into electrical equipment cost 20 cents and was required in large quantities. It was manufactured by purchasing standard fittings and then modifying them. Manufacturing alternatives were later provided in the creative phase of a manufacturing value study. The finding was that the parts, made from tubing by semiautomatic machines, could be purchased for 5 cents each. The roadblock clearly was a statement put on the drawing. For the guidance and instruction of the purchasing department. It said, "Purchase stainless fitting, modify as shown by the drawing". Again, with the roadblock clearly in view, action could, as is usually the case, be taken to overcome its costly effects. A review with the engineer disclosed that when the item was designed ten years earlier it was a relatively low-volume item, and the most economical way to provide the fitting was as specified. Sometime during the years, matters changed so that the opposite situation was now true. Of course, there was no reluctance on the part of engineering to immediately strike from the drawing this roadblock specification.

EXAMPLE 3: "It is patented". A rather complicated arrangement was used to support about fifty pounds of rotating equipment on a high-volume product. Application of value analysis techniques quickly brought forth the information that a simple construction for the support would cut cost by 40 cents and result in an annual saving of $24,000. However, the objection arose that the simple construction could not be used because it was patented. The roadblock came into clear view. Obviously, the simple construction should not be used if it were covered by a valid competing patent and if $24,000. A patent search was initiated, and soon the attorney reported that there was no patent in existence that read on the simple construction which would most effectively and economically accomplish the function. This eliminated the roadblock and allowed action to simplify and improve the design, with the additional benefit of eliminating the $24,000 of unnecessary cost,

The fact remains that this "belief, until corrected, was just as effective in adding $24,000 to the cost as some additional customer requirement or additional new feature would have been.

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EXAMPLE 4: "Underwriters' wouldn't approve it". A very simple and functional design for socket to hold a light bulb was suggested by a value analysis study. The verdict of the engineering people of one company was that the design would accomplish the function reliably but that it would never be approved by Underwriters'. Hence it was not adopted. Again the roadblock was in clear view. It is interesting to note that a socket incorporating the main features of the is proposed design was put on the market by another manufacturer a few months later. It bore the stamp of Underwriters' approval as it should have, because it accomplished its function with total reliability and total safety.

This specific technique of identifying and overcoming roadblocks is another item in the kit of tools which is positively essential for the professional value engineer to learn to use effectively

10.5.5 IT WONT WORK

Truth is indeed often stranger than fiction. A most interesting and typical example of such a situation is the case in which 800 small brass cams were required per year. These cams were being machined from 3/l6inch brass material, and because of their unusual shape, the machining operations did not lend themselves to any simple mechanical routine. Because the quantities were so low, it had also been determined each time a change was considered that it would certainly not be economical to purchase tools for stamping them out.

The value engineer, in looking at the job and in creatively searching for alternatives, felt that it was worthwhile to consider the use of a Kirksite die. Kirksite resembles lead and is commonly melted and poured into a die around a model of the part required. When it has set, it is hard enough to be used for a tool to blank out a good quantity.

A manufacturing methods engineer, whom the value analyst succeeded in interesting in the project, decided it had a chance of working and thought he would like to try it. Hence, he asked his boss for a shop order of $50 to give it a try. He didn't get it. The boss said, "It won't work". Meanwhile, the engineer's interest in the project grew, and he went on to tell the boss's boss what he had in mind and said he wanted the $50 to try it. Again he was told, "It will never work". By now he had become so enthusiastic about the idea and so involved in it that he decided to run the risk of going to the top and telling the manager of manufacturing about it. This he did; once more he asked for the needed $50 shop order, only to be told that he couldn't have it because "it wouldn't work".

During the following few days, the ideas stayed with him, and his frustration turned into constructive emotion. He decided he would do it anyway and charge it to another shop order which he already had. It worked. The demonstration was amazing. He decided to get the worst over first by telling the manager of manufacturing, and when he did, he was immediately given an opportunity to demonstrate. The amazed manufacturing manager called in a number of his subordinates and they were given the same demonstration. These people, in turn, called in a number of their engineers for a demonstration. Each time a few pieces were run off and checked for dimension.

" An interesting happening was that, at the end of the day when the parts were viewed, it was decided to send them to the storeroom for use in production; as they were counted, it was found that they made up enough parts for two years of production.

After a roadblock is identified as such and eliminated, it appears very simple; prior to this, however, it is formidable and totally stops action.

10.5.6 UNDERWRTITERS WON'T ALLOW IT

An electronic control contained twelve binding screws. The function of these screws was to hold small wires in positive contact on their terminals. Quantities were 50,000 controls per year which meant 600,000 screws. The screws cost $6 per thousand although they were very similar to screws which cost $2 per thousand.

Why this tree times increase in the cost? The answer was that although $2 per thousand would buy small No.8 screws with smaller No.6 heads. This made the screw a special. The use of technique 12, "utilize applicable standards", showed that two-thirds of the cost might be unnecessary. When the question of "Why"? was raised, the answer from technical people involved was, "Underwriters" requires a No.8 screw". Examination of the assembly showed that, as it was made, the head of the No.8 screw was slightly too large to facilitate assembly in the installation of one of the twelve screws. Hence No.6 heads were put on No.8 shanks for all of the screws. When the question was properly explored with Underwriters', its answer was, "We felt it desirable to specify a No.8 screw so that it would have a large-enough head to make extra-positive contact with the small wires".

Now that this roadblock was illuminated with more facts, it was obvious that putting the large shanks on the screws at three times the cost made no contribution of any kind. As a result, Underwriters' was asked to reexamine

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Check Your progress

1. What are the applications of VE?
2. What are the various phases of VE in Sales?
3. What do you mean by integration of value analysis in sales?
4. What is the benefit of value training in manufacturing?
5. How does value consultant help in sales department?

the application, and it subsequently approved a screw which cost $2 per thousand-one-third of the cost-as totally functional and safe.

In this case, as in many others, better answers did not come forth until the technique, "identify and overcome roadblocks", was applied.

Use Industry Specialists to Extend Specialized Knowledge

Getting an acceptable degree of value means accomplishing functions as well as competition does. Getting good-grade value means doing it better. The former is accomplished by getting answers as good as competition's; to accomplish the latter, better answers are required.

The question then is how to get better answers. The procedure is as follows:

Establish clearly in the mind exactly what is to be accomplished, i.e., precisely what functions are desired.

Place better alternatives before the decision makers.

Get an action pattern established so that the information on the best alternatives will be promptly used in decision making.

In providing better answers for the accomplishment of each function, we must first ask: What analogy is involved? For instance, does the problem primarily involve:

The quality of the answers suggested is dependent upon a number of things. Obviously, one of the most vital is the depth of penetration of the subject matter brought to bear on the problem. If we take the known penetration of any technology as 100 percent, what depth of penetration into such applicable can be expected in any specific instance? Is the answer, say, 25 per cent penetration? Probably not or at least not in more than a certain few technologies. In most cases it is reasonable to assume that we get down considerably lower.

Let us assume that the personnel concerned with developing and selecting engineering and manufacturing alternatives which establish the degree of value in their product apply a knowledge penetration of 10 per cent on the average. The result of the answer than arrived at, compared with the answer which could be obtained with available knowledge applied, cannot be good. Special knowledge in depth in the areas involved must be brought into the work to a greater extent before decision making. Furthermore, it must be remembered that knowledge, techniques, and process are continually being developed in each technology and that only the specialist know the those which have became practical within the last year or two. Of still greater importance is the face that these industry specialists are continuously working on advancing knowledge in each technology. The developments they complete one year will begin,

perhaps, to come into usage the next year and will gain increasing use during the years immediately following. Only the bringing these specialist into touch with the functions needed in the product can the better answer derived from the latest within their technology be obtained so that a good or excellent degree of value may be ensured.

10.5 SUMMARY

Value Engineering can be applied to all the functional areas. It need not be restricted to Manufacturing activities. It can be applied to Sales, manufacturing etc., the various phases of VE are: Integration, Value Appraisal and Product Evaluation, Consultation, Value Training

10.6 ANSWER TO CHECK YOUR PROGRESS

1. What are the applications of VE?\

   Value Engineering can be applied to all the functional areas. It need not be restricted to Manufacturing activities. It can be applied to Sales, manufacturing etc.,

2. What are the various phases of VE in Sales?

   These are: Integration, Value Appraisal and Product Evaluation, Consultation, Value Training

3. What do you mean by integration of value analysis in sales?

   Integration makes sure that each salesman, each sales engineer, and each development engineer working in sales is fully advised on what the value consultant's work is and how he will work with them.

4. What is the benefit of value training in manufacturing?

   Men in manufacturing would make decisions on processes, shapes, exact arrangements, and similar factors which are needed to provide the functions expected by the engineers can derive large benefits from having a basic understanding of the use of the value analysis techniques. Accordingly all men should be included in suitable training programs.

5. How does value consultant help in sales department?

   With reference to both new products and existing products, sales people are directly oriented toward providing the desired function to their customers at competitive prices. On the invitation of sales people, the value consultant proceeds to study the functions involved. He applies the value analysis techniques to develop values for the functions, value alternatives, and alternative courses so that the sales people may make, or promote, decisions which will meet their objectives.

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